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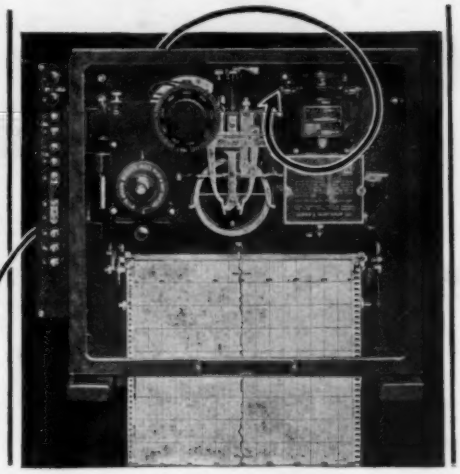

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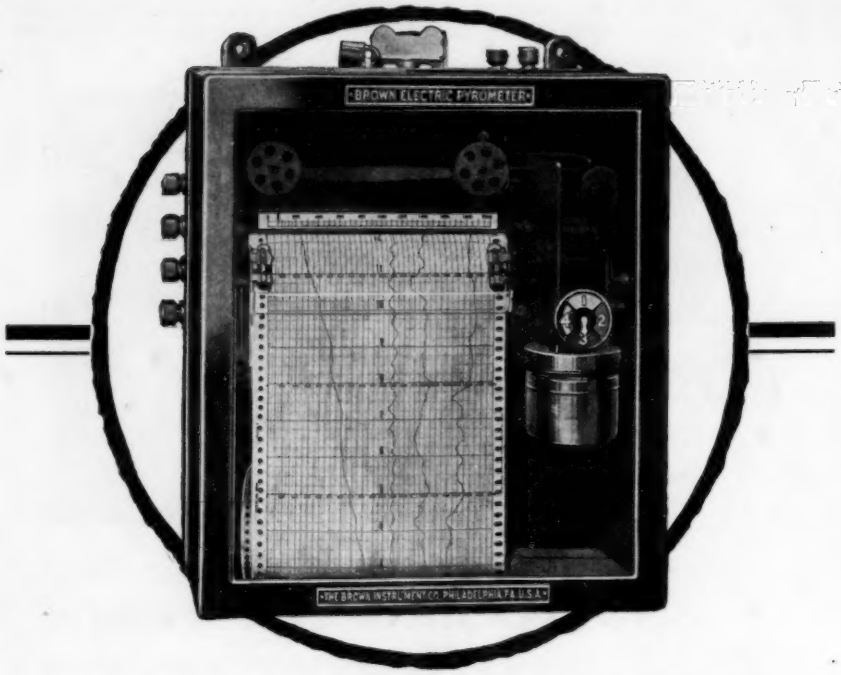

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Table of Contents

JANUARY, 1928

The Journal

Progress Report on the Efflorescence and Scumming of Mortar Materials—Wilson 1
Discussion on "Kiln Construction"—Garve 32
A Petrographic Study of Some Slags from Boiler Furnaces—McDowell and Lee 35
Firing Open Terra Cotta Kilns with Gas—Owen 42
Some Investigations of a Nebraska Clay—Rymes 46

Ceramic Abstracts 1

The Bulletin

Editorials

Integration of Interests in Ceramic Technology 1
Our 1928 Meeting 3

Papers and Discussions

A Glass Factory in the Days of Nebuchadnezzar—Marshall 5

Activities of the Society

Ceramists' Tour Abroad 10
New Members Received from November 1 to December 1, 1927 16

News from the Local Sections

California Section 17
Chicago Section 17
Pacific Northwest Section 17
Pittsburgh Section 18
Michigan-Northwestern Ohio Section 18

Notes and News

Obituaries 20
Ceramic Short Course at the University of Illinois 20
Proposed Simplified Practice Recommendation No. 79 20

Calendar of Conventions 24

Advertisers' Index 25

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PROGRESS REPORT ON THE EFFLORESCENCE AND SCUMMING OF MORTAR MATERIALS[1]

By Hewitt Wilson[2]

ABSTRACT

A general discussion is given on soluble salts in clays, clay products, and mortar materials and on the addition of barium compounds to make the salts insoluble. Twenty-one, 4- x 4-foot panels, 8 inches thick were constructed of the same glacial-clay, red, face brick with variations in the following common mortar materials: sand, slaked lime, hydrated lime, and Portland cement. Saturated brick was tried versus dry brick; sea water was used to replace fresh water; machine-mixing of the mortar batch was tried against hand-mixing; and various percentages of barium carbonate, barium hydroxide, and barium chloride were introduced to make the calcium sulphate insoluble. Temporary scum or that obtained in the original drying of the wall was noted and later or permanent scums, produced by artificial and natural soaking and drying the walls were studied for over a year.

Results All the mortars studied can be made to scum if sufficient water and time of contact of water and mortar are provided. The troublesome salts are: (1) calcium sulphate largely introduced by the Portland cement, which makes a very bad, early scum; (2) calcium hydroxide from the free lime and hydrolyzed calcium aluminates and silicates in Portland cement and from uncarbonated lumps of lime in the lime mortars; in addition, some minor salts from special sources, such as sodium chloride from sea water Lime mortar streaks were only produced after a large quantity of water had been washed through the panel, and were apparently formed by finely divided or colloidal lime hydroxide or carbonate in suspension in the water running from the porous mortar down the side of the wall. This is a very severe soaking condition and is not common in the ordinary building wall. The lime sulphate dissolves readily enough to pass in solution through the pores of the brick and to spread uniformly over the brick surface. Lumps of hardened lime should be removed from both slaked and hydrated lime to prevent streaks of lime hydroxide and carbonate on the surface under wet conditions for long periods of time. Lumps of lime also produce spalling. The interior of a wall should be well protected from leaky drains, gutters, etc., which permit water to get inside. A hard rain of short duration is not as bad as a long, soaking drizzle which permits the water to remain in contact with the mortar for a longer period of time. Cement products, such as artificial cement stone, commonly release salts which drain onto other facing materials.

The tests indicated that barium carbonate is effective under normal conditions in preventing or minimizing calcium sulphate scum from Portland cement. This has been checked on large Seattle school buildings where the conditions are favorable for scum. Five per cent barium carbonate in terms of Portland cement has been used successfully. It has been suggested (but not tried) that diatomaceous earth may combine with the free lime of the mortar materials to produce a more insoluble calcium silicate and reduce the temporary scum of lime hydroxide.

The study is being continued on the chemical analysis and composition of the scums taken from the surface of the walls and leached in the laboratory from separate batches

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[1] Coöperative study between the Pacific Northwest Brick and Tile Association and the University of Washington. Received Aug. 31, 1927.

[2] Assisted by T. E. Nicholson, Henry N. Baumann, Jr., and Howard Mansur.

of the mortar materials. Preliminary analyses have already been made. The strength of the mortar materials to note the effect of barium salts is also under study. No deleterious effects have been found from barium salts.

General Discussion of Soluble Salts in Clays and Clay Products

While clays represent the end point of silicate rock decomposition, they are not free of soluble materials, because they contain certain amounts of partially decomposed silicate rocks as sand grains; they are subject to the contamination of ground waters carrying salts in solution and often contain soluble, secondary minerals. The colloidal clay particles adsorb certain quantities of these salts to their surface but other salt portions can be removed by washing.

Mellor[3] found that some ball clays released 0.4% soluble salts while china clays gave only 0.015% soluble matter. Other investigators have found from 0.0 to 1.5% salt content though it is probable that as high as 5.0% can be obtained from some clays by the proper treatment.

We may divide these salts into two classes. The first are the very soluble salts of the alkalis or borates. They are of rare occurrence save in the desert or alkali regions. Their distribution is apt to be very irregular; the surface or soil may be heavily loaded while the buried strata may be comparatively free. Such salts have low melting temperatures and act as fluxing materials, particularly on those surfaces which have been exposed during the drying of the clay. They may even produce better colors than those which normally could be produced with the clay and may dissolve the more resistant lime sulphate scums during firing. Boron or alkali salts are often added to the underglaze clay coatings of terra cotta to provide better adhesion to the body.

The second class of soluble salts is far more common and troublesome. Calcium sulphate (gypsum) is the worst offender while magnesium sulphate, iron sulphates, and vanadium salts are found in smaller quantities. While one part by weight of gypsum requires 415 parts of water to dissolve it, yet the water used for tempering plastic clay is able to carry enough of the salt to the surface of the ware and deposit a white scum on drying. $CaSO_4$ is not decomposed until about 1200°C which is above the maximum firing temperature for many red firing clay wares. The white efflorescence is more apparent against the dark background of red firing clays than on a buff or white body. During vitrification, however, the silicates of the clay will attack and dissolve the calcium sulphate. Hence, while a soft-fired brick may appear badly scummed, a vitrified product of the same body may be free

[3] J. W. Mellor, "The Determination of the Amount of Soluble Salts in Clays," *The Pottery Industry*, **1**, 53 (1914), Charles Griffen and Co.

of "whitewash." Undecomposed sulphate in the interior of a fired clay body may be brought to the surface by rain or other penetrating waters.

Iron salts are likewise brought to the surface of clay wares. They are not noticed on the red-brown clays but may be found as irregular dark patches on the lighter colored wares, and may be used to add an attractive polychrome effect to structural brick or tile. Vanadium salts[4] may resist silicate combination to high temperatures and later produce yellow-green efflorescence which may be used to advantage on face brick but which is unsightly on light colored, slip-coated terra cotta.[5] Iron salts may also be responsible for some of the yellow-green scums.[6]

In the manufacture of architectural terra cotta another trouble is found from soluble salts. If a coating of lime sulphate has formed on the surface of the clay body during drying, it is very difficult to obtain perfect contact or adhesion of underglaze coatings which merely vitrify and do not come to a state of complete fusion. Glazes on the other hand eat their way through any sulphate coating and produce a strong adhesion to the clay body by solution. Hence it is necessary to remove or prevent the formation of a lime sulphate coating.

Elimination of Soluble Salts

The most common method is the addition of barium carbonate, hydroxide, chloride, or fluoride to the clay body before or during tempering. In the case of the carbonate addition, the products of the reaction are the more insoluble calcium carbonate and barium sulphate:

$$CaSO_4 + BaCO_3 = CaCO_3 + BaSO_4.$$

Apparently calcium hydroxide, calcium chloride, and calcium fluoride do not produce the trouble caused by calcium sulphate, even though the former are more soluble and are carried to the surface of a drying mass of clay in greater quantities. Calcium hydroxide is rendered insoluble by contact with the carbon dioxide of the atmosphere but is one of the common scums on brick walls with lime mortars or cement mortars which contain free lime. Calcium chloride is strongly hygroscopic and both the chloride and fluoride are decomposed at comparatively low temperatures during firing. Calcium sulphate can be decomposed at lower temperatures if a reducing atmosphere is maintained in the firing process.

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[4] Hermann A. Seger, Collected Writings, Vol. 1, pp. 381–86.

[5] Earl R. Curry, "Note on Green Scumming," *Jour. Amer. Ceram. Soc.*, **9** [6], 392 (1926).

[6] C. W. Hill, "Notes on the Green Staining of Clay Wares," *Bull. Amer. Ceram. Soc.*, **1** [2], 51 (1922).

Amount of Barium Salts Needed It has been suggested from various sources that twice the amount of carbonate should be used as that theoretically required to precipitate the sulphates. The active portion of the barium carbonate will vary with the reactivity of the carbonate and the amount adsorbed by the clay particles. Some is lost by the lack of intimate mixing of the salts throughout the clay mass. The amounts commonly used vary from 0.5 to 1.0% of the dry weight of the clay body. While this is in excess of that required, some insurance should be given to take care of the variation of soluble salt content in different shipments and different portions of the clay bank.

TABLE I

SOLUBILITY OF CERTAIN SALTS*

Salt	Molecular weight	Solubility in 100 parts of cold water	Salt	Molecular weight	Solubility in 100 parts of cold water
$CaSO_4$	136	0.179	$FeCO_3$	116	insoluble
$CaSO_4\,2H_2O$	172	0.241	$FeCl_2\,4H_2O$	199	160.1
$CaCO_3$	100	0.0013	$Fe(OH)_2$	90	0.00067
$Ca(OH)_2$	74	0.17	$Fe(NO_3)_2\,6H_2O$	288	200.
$CaCl_2$	111	49.6	$FeCl_3$	162	74.39
$CaCl_2\,6H_2O$	219	37.3	$FeCl_3\,6H_2O$	270	246.
CaF_2	78	0.0037	$Fe(OH)_3$	107	insoluble
$Ca(NO_3)_2\,4H_2O$	236	134.	$Fe(NO_3)_3\,9H_2O$	404	very soluble
CaS	72	decomposes	Na_2CO_3	106	7.1
$MgCO_3$	84	0.0106	$Na_2CO_3\,10H_2O$	286.2	21.52
$4MgCO_3 \cdot Mg(OH)_2\,5H_2O$	486	0.04	$NaHCO_3$	84	6.9
$MgCl_2\,6H_2O$	203	167.	NaCl	58.5	35.7
$Mg(OH)_2$	58	0.0009	NaF	42	4.0
$Mg(NO_3)_2\,6H_2O$	257	200.	NaOH	40	42.
$BaCO_3$	197	0.0022	$NaNO_3$	85	72.9
$BaCl_2\,2H_2O$	244	36.2	Na_2SO_4	142.1	5.02
BaF_2	175	0.163	$Na_2SO_4\,7H_2O$	268.2	19.6
$Ba(OH)_2\,8H_2O$	316	5.56	$Na_2SO_4\,10H_2O$	322.2	12.17
$Ba(NO_3)_2$	261	5.2	Na_2SO_3	126.1	14.1
BaS	169	decomposes			

* Handbook of Chemistry and Physics. The Chemical Rubber Company.

Other methods of a more direct nature than the quantitative determination of the soluble salt content for estimating the amount of barium salt needed, have been devised: (*a*) in each of several 500-cc. bottles are placed 100 grams of clay and enough water added to fill the bottles $\frac{3}{4}$ full. They are shaken thoroughly and allowed to stand until the clay has become finely divided. A 1% solution of barium chloride is then added to each bottle; one cc. to the first, 2 cc. to the second, etc. The bottles are stored in a warm place for 12 hours with occasional shaking and after the clay has settled, 100 cc. of the clear supernatant liquid are drawn off through a filter and a few drops of sulphuric acid

added. If turbidity develops, the bottle contains an excess of barium chloride. The lowest amount of chloride which develops turbidity is the one to use.[7]

(*b*) The second method is similar to the first, save that barium carbonate is added directly to the clay suspensions in small increasing amounts and barium chloride is added to detect the lack of carbonate. If enough carbonate has not been added to take care of the sulphates, the barium chloride will produce a white precipitate of barium sulphate with the excess of calcium sulphate.

FIG. 1.—General view of panels, August, 1927.

As the chloride and hydrate of barium are readily soluble and an excess would itself produce a coating on the dry clay body, it has been the practice to add an insufficient amount of chloride or hydrate and make up the remainder as carbonate. The latter is very slow in its action. Another method (patented) consists of adding cheap sodium carbonate (soda ash) to precipitate the excess chloride or hydrate. This likewise deflocculates the clay and reduces the water content. An excess is injurious to the hands of the workmen. "Black ash" or the impure soluble sulphide of barium is now on the market and is a cheaper source of barium salt. It forms barium hydroxide and hydrogen sulphide when wet and hence is rather disagreeable to handle. It is best mixed with the clay in the dry pan.

Determination of the Amount of Soluble Salts

The quantity and nature of the soluble salts can be determined by solution in pure water, filtration, evaporation, and a quantitative determination of the composition of the filtrate.

[7] C. W. Parmelee, "Soluble Salts and Clay Wares," *Jour. Amer. Ceram. Soc.*, **5** [8], 538 (1922).

Large quantities of water and long periods of time for solution will be needed to dissolve these slightly soluble salts. Boiling water will probably shorten the time of solution but likewise will tend to break down some of the silicates. If the determination is for the purpose of estimating the scumming properties of a piece of fired clay ware, the sample investigated should be that which has been fired to the proper temperature. The colloidal clay will release a large portion of its adsorbed soluble salt content when heated to low temperature and this portion is not usually determined by solution at ordinary temperatures. At vitrification temperatures another portion of the soluble salts is taken into insoluble silicate combination by pyrochemical reactions.

The problem of separating the soluble salts in the molecularly dispersed state from the clay particles in the colloidally dispersed condition likewise presents difficulties. The colloidal clay particles will pass through the ordinary filter papers, but will be retained by bisque or alundum filters which must be operated at low pressures. A much easier method consists of flocculating the colloids with acids or salts, settling the clay, and washing by decantation. The solution of silicates by sufficient acid to bring the clay to the isoelectric point should be small. Centrifuging is another method for settling the suspended colloidal matter.

Approximate determinations of the soluble salt content can be made by the electrical conductivity method as shown by Bleininger and Kinnison.[8]

Reactivity Test for Barium Salts

The value of barium carbonate for neutralizing soluble salts depends upon its activity when in contact with these salts. Activity test:[9]

Weigh out 2 grams of barium carbonate sample and place in 100 cc. of a 10% solution of magnesium sulphate. Allow to stand one hour at 70°F stirring at 10-minute intervals with a glass rod. Filter and wash with water until no precipitate shows when tested with barium chloride. Wash precipitate consisting of barium sulphate and barium carbonate, which has remained unchanged, into a beaker and treat with dilute hydrochloric acid. Collect the barium sulphate now remaining by filtering the washing with warm water until the filtrate is free of barium chloride as shown by testing with a drop of sulphuric acid. Ignite and weigh. Correct this weight by subtracting the weight of barium carbonate sample which is insoluble in dilute hydrochloric acid. Convert the weight of barium sulphate into terms of barium carbonate ($BaSO_4$:$BaCO_3$::233:197). This weight divided by the weight of the sample of barium carbonate taken, times 100, equals the per cent of barium carbonate which has reacted with the magnesium sulphate.

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[8] A. V. Bleininger and C. S. Kinnison, "Electrical Conductivity of Clays," *Trans. Amer. Ceram. Soc.*, **15**, 523 (1913).

[9] W. L. Howat and G. A. Williams, "Testing Barium Carbonate for Use in Terra Cotta Bodies," *Bull. Amer. Ceram. Soc.*, **2** [6], 161 (1923).

The test depends on (1) the concentration of the soluble sulphate salt used, (2) the temperature, (3) the kind of soluble sulphate used, and (4) the time. The longer the clay body is aged and the warmer the temperature, the more effective will be the action of the barium carbonate. Grinding a sample of barium carbonate increases its activity but a finer sample of a different variety is not necessarily the more reactive. Barium carbonate which shows a reactivity in the above test of less than 25% is doubtful material. Commercial witherites at $50.00 to $60.00 per ton have shown only 23% reaction while precipitated carbonate at $70.00 to $80.00 will be from 36 to 38% reactive. The more expensive but readily soluble chloride or hydroxide may prove the cheaper on the basis of reactivity and barium content.

COST OF BARIUM SALTS

Molecular form	Mol. wt.	N. Y. cost T ($)	Ba (%)	Cost "Ba" Basis ($)	Reactive (%)	Cost reactive basis ($)	Cost "Ba" and reactive basis ($)
$BaCO_3$	197.4	55.00	70	78.50	38	145.00	207.00
$Ba(OH)_2\,8H_2O$	315.5	110.00	44	250.00	100	110.00	250.00
$BaCl_2\,2H_2O$	244.5	65.00	57	114.00	100	65.00	114.00

Methods of Adding Barium Salts

(1) Barium carbonate is commonly added to the clay batch or to one of the clays just before grinding in the dry pan, wet pan, or mixing in the soaking pit.

(2) As the per cent of water added to the prepared body in the pug mill is held fairly constant, the carbonate may be added by means of the tempering water. Batches may be weighed and dispersed in water tanks which are provided with constant agitation and these suspensions are used for tempering as needed. Continuous feeders can be arranged to supply the powdered barium carbonate at a uniform rate to a steady flow of water, based on the average rate of use. Blungers or tube mills can be used for dispersion.

(3) The more soluble hydrate or chloride may be fed at a constant rate by a floating siphon.[10] Sprinkling the powdered carbonate over the wet clay in a pug mill is a very wasteful, inefficient, and inaccurate method.[11]

Other Sources of Scum

Scumming or efflorescence may likewise be produced on structural units from sulphur in the fuel used for firing soluble salts in mortars and

[10] M. E. Gates, "Using Barium Hydrate in Terra Cotta Bodies," *Jour. Amer. Ceram. Soc.*, **3** [4], 313 (1920).

[11] Hewitt Wilson, "Manufacture of Terra Cotta," *Bull. Amer. Ceram. Soc.*, **5** [2], 99–102, 137, 138 (1926).

other adjoining materials. Green or yellow spots on brick or terra cotta may be fungus growth on rough or porous surfaces.

Individual Properties of Various Soluble Salts

At this time, we can only point out a few of the unsolved portions of this problem. Calcium sulphate appears to be the most troublesome salt of efflorescence. This is probably due to its low solubility in water and in the ordinary acid cleaning solutions; its ability to cling to rough,

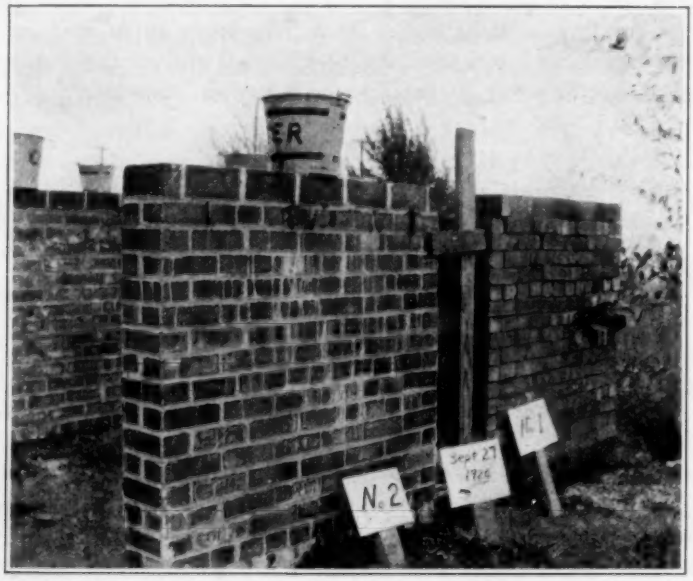

FIG. 2.—Panels 1 and 2, Sept. 27, 1926. Panel 1 with no mortar has never given any scum. Panel 2 of lime-sand mortar shows the streaks of calcium carbonate after excessive flooding and soaking with water. No temporary or drying-out scum.

fired, clay surfaces and difficulty of removal by rain water or wind; its resistance to decomposition at many of the red brick firing temperatures; its universal distribution and comparatively large proportion of the soluble salt content. Calcium hydroxide or lime water, on reaching the surface is converted to the carbonate which is easily soluble in dilute hydrochloric acid. The hydroxide of lime is but a temporary form until the carbon dioxide of the atmosphere can change it to the more insoluble carbonate form. The lime content of Portland cement may be a source of a permanent scum.

Efflorescence of Brick Mortars

The foregoing is a description of soluble salts in natural clays and the common methods which may be used to neutralize their activity.

It has been found, however, that a large portion of the efflorescence which is found on the surface of brick in the wall is not due to soluble salts in the clay brick but comes from the mortar and accompanying materials.

The older types of mortar consist of mixtures of sand and slaked lime. The latter is made by adding water to quicklime (CaO) and slaked lime or calcium hydroxide ($Ca(OH)_2$) is formed; 0.17 parts of this are soluble in 100 parts of cold water. Hence slaked lime itself when

FIG. 3.—Panel 3 (right) and Panel 6 (left) are constructed of cement-sand mortar. Wet brick give a strong drying-out scum.

fresh may cause a temporary scum in the wall if laid during wet weather or if the brick work is well saturated. However, this is a temporary type of scum since the slaked lime in setting and hardening changes back to calcium carbonate or to a comparatively insoluble form. Carbon dioxide in the air will thus change a scum which has been precipitated as the hydroxide on the surface, to the carbonate after a brief exposure to the atmosphere. Slowly carbonating lumps of lime or slaked lime which have not been disintegrated in the mortar box may thus continue to give off calcium hydroxide from the interior of a wet wall and cause streaks of scum for a long period of time. While this is a potential source of scum, we do not believe that it is a very

common form because of the comparative freedom of the old lime mortars from the streaked type of efflorescence unless the wall is laid during wet weather or the wall is subjected to excessive wetting.

More trouble was found in recent years when Portland cement was introduced into the mortar mixture for quicker setting and greater strength. After clinkering, between 2 and 3% of gypsum (calcium sulphate) is ordinarily ground into the Portland cement batch to retard the time of set. As noted before, calcium sulphate is the worst scum-producing salt which is found in natural clays and is the one which the brick manufacturer has been fighting with barium compounds for several generations. His worst enemy thus reappears in the newer, mortar mixtures. All Portland cement products are likewise affected but as most of them are of the light gray colors, the white scum is not very noticeable. However, when this scum drains down a wall over dark-colored materials, the contrast in color is easily distinguished. Portland cement may also contain a certain amount of free lime which is likewise a source of the hydroxide scum.

Solubility of Portland Cement

Benson[12] found that the lime content of Portland cement, in both the unhydrated and hydrated condition was almost completely removed by the leaching action of water containing fir needles and bark; 44% of the Portland cement was removed as lime hydroxide by shaking one gram of Portland cement with 1800 cc. of distilled water at 25°C for 4 hours. At this rate a small leak of water, which passes through a cubic foot of concrete work at the rate of one drop per second will carry off 23.7% of the cement in a year's time. This is serious enough to affect the strength of the cement as well as to cause considerable scum of lime hydroxide and carbonate. Such data have been checked by the failures of dams and reservoirs of concrete construction in various parts of the country. The source of lime is not only the small amount of free lime which is to be found in most Portland cements but lime hydrate is also formed from the hydrolysis of the main constituents of the Portland cement, the calcium silicates, and calcium aluminates.

The sand used in mortars may contain sulphates and if it has come in contact with sea water, a small amount of common salt or sodium chloride may be found clinging to the surfaces of the sand grains. Different mortar colors contain varying contents of soluble ingredients. By contrast in color, darker mortars likewise reveal the presence of a deposition of salt on their surface even though it may have originated from another source.

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[12] H. K. Benson, Herrick, and Matsumoto, "Solubility of Portland Cement in Weathering Agents," *Ind. Eng. Chem.*, **16**, 1063 (1924).

Brick Panel and Mortar Experiments

In order to study the problem of efflorescence in mortar materials, a coöperative agreement was made between the Pacific Northwest Brick and Tile Association and the Department of Ceramic Engineering, College of Mines, University of Washington. Sixteen brick panels were erected in May, 1926 at the expense of the Association and three were later added by the University.

FIG. 4.—Lime-cement-sand mortar and dry brick were used in Panel 4 (left). This has always been a good panel with little scum. The mortar of Panel 5 (right) is composed of lime and sand with wet brick. It shows some of the streaks of calcium hydroxide or carbonate.

Description of the Panels[13] Each panel is four feet wide, four feet high, and eight inches thick, with the two sides and the two ends faced for observation and study. The top row of brick is laid on edge around the outside making a trough effect, for the introduction and retention of water during the soaking tests. Each panel is placed on a row of three 2- x 4-inch wood rails standing on edge, to keep the brick work from ground contamination.

[13] Brick made by the Builder's Brick Company, Seattle, Wash.; lime putty, Galbraith and Co.; sand, Galbraith and Co. from their Queen Anne Hill pit and washed in fresh water; cement brick used in Panel 9, Shope Concrete Brick Co., 3rd West and Fulton Streets, Seattle; Superior Portland cement from Concrete, Wash.; The Biber waterproofing compound used in Panel 16 donated by the Biber Waterproofing Co., Seattle, Wash.

It was desirable to have a dark red brick which would not itself release salts, which would have a smooth surface, enough continuous pore space to permit the passage of small amounts of water by capillarity, made of a commonly used Pacific Northwest type of clay, and would not have discolorations or uneven variations in color from kiln or drier scum. Smooth dark red face brick were selected. These brick were made from a commonly used, Puget Sound, glacial clay; they were fired in wood-fired, round, downdraft kilns and as far as known at the time of selection were the only local red clay brick into which barium carbonate had been introduced before molding, to eliminate the soluble salts present in the clay. The percentage absorption in a five hours boiling test varied from 4.4 to 13.6% with an average of 10.2% in 14 samples.

General Mortar Composition

		Pounds
12 buckets sand		390 sand
4 " lime putty	or	60 lime
¼ sack of cement		52 cement
		45 water
		547 total weight

The bucket was 10 inches in diameter and 8 inches high. This batch gave enough mortar for the 180 brick plus enough for casting of five brick in wooden molds for further testing.

Variation in Composition. I. Production of Efflorescence in Dry Brick

Panel 1: Brick alone, no mortar of any kind. A part of this panel was used later to finish out another panel.

Panel 2: Lime mortar, no cement. One part of lime putty to 3 parts of sand. Dry brick.

Panel 3: Cement mortar, no lime putty. Dry brick. One sack of cement to seven cu. ft. sand.

Panel 4: Lime-cement mortar. Dry brick. 12 buckets sand, 4 buckets lime putty, and 52 pounds cement.

Soaked Brick

The brick were soaked by complete immersion for over fifteen hours in a tank of water and were laid as soon as withdrawn from the water. In this condition they were hard to lay. This represents extreme conditions but introduced a large quantity of water into the wall.

Panel 5: Soaked brick, lime mortar, no cement. Same mortar composition as Panel 2.

Panel 6: Soaked brick, cement mortar with no lime. The mortar composition is that of Panel 3.

Panel 7: Soaked brick with cement-lime mortar. The mortar composition is that of Panel 4.

Sea Water

Panel 8: Dry brick with lime mortar and no cement, in which all the water used save that of the lime putty was salt water taken from Puget Sound. This introduces a greater salt content than the sand which has just been washed in salt water and then drained or partially dried.

Cement Brick

Panel 9: Dry brick with lime mortar and no cement. The two upper rows of the panel are cement brick with red brick beneath

II. Prevention of Efflorescence

Addition of Barium Compounds

Panel 10: Dry brick, lime cement mortar; 5% (2.6 pounds) barium carbonate in terms of the weight of the cement, were dry mixed by hand with the Portland cement before adding to the lime and sand.

Panel 11: Mortar composition was the same as Panel 10. However, the mortar was mixed five times in a brick machine after the lime putty had been mixed by hand with the sand and had stood over night. This was intended to give a very thorough mixing to compare it with the ordinary hand mixing on the small job.

Panel 12: Mortar composition was the same as that of Panel 10. The barium carbonate in this case was soaked with the lime putty for five hours instead of being mixed in with the dry cement.

Panel 13: 5% or 2.6 pounds of barium hydrate were used with dry brick, lime-cement mortar. The hydrate was dissolved in warm water and was added in small quantities to the pug mill as the dry cement was added to the lime-putty sand mixture. The mortar was mixed three times.

Panel 14: This is the same as Panel 13, save that 3% or 1.56 pounds of barium chloride were used as the precipitant.

Panel 15: This is the same as Panel 13, save that 2% or 1.04 pounds of barium chloride together with 3% or 1.56 pounds of barium carbonate were used as the precipitant.

Panel 16: Dry brick, lime-cement mortar in which Biber waterproofing material has been mixed with the mortar in the ratio of 1.5 pounds of waterproofing to 150 pounds of mortar.

Barium Compounds with Soaked Brick

Panels were constructed August 17–19, 1926. Since those constructed of wet brick gave greater amounts of temporary scum or that

produced during the initial drying of the brick work, than those of dry brick, it was thought necessary to determine the effect of barium compounds under the more severe conditions.

Panel 17: Soaked brick, with cement-lime mortar containing 5% or 2.6 pounds of barium carbonate. Mixing was done by machinery.

Panel 18: Soaked brick, with cement-lime mortar containing 5% barium hydrate; mixed by machinery.

Panel 19: Soaked brick, with cement-lime mortar containing 3% barium chloride; mixed by machinery.

FIG. 5.—Panel 7 (right) has the same composition as Panel 4, but soaked brick were used. It has given more scum than Panel 4. Panel 8 (left) was made with dry brick and lime-sand mortar using sea-water from Puget Sound. This made a very weak mortar which was partially washed out of the upper joints and the sodium chloride scumming was bad after the panel was soaked. Sufficient leaching may remove these soluble salts.

The lime putty used for the last three panels, Nos. 17, 18, and 19 was furnished by the University and contained large lumps of unslaked lime which later caused trouble by streaking and spalling.

Other Tests of Mortars

Sufficient mortar was made of each composition to lay the 180 brick and mold five 8- x 4½- x 2½-inch brick samples in wooden molds. These were permitted to remain in the molds for several months. Unfortunately those of the first 16 panels were stored after a few days' time

in a dry building and the cement probably did not obtain its maximum strength. The mortar brick from the last three panels were given seven days under water after an initial setting period and then left to dry and age under cover near the panels during the winter months.

These mortar brick were made to obtain comparative data on: (1) hardness and strength of mortars, (2) per cent water absorption, and (3) weight and composition of the salts which can be leached out of the mortar materials.

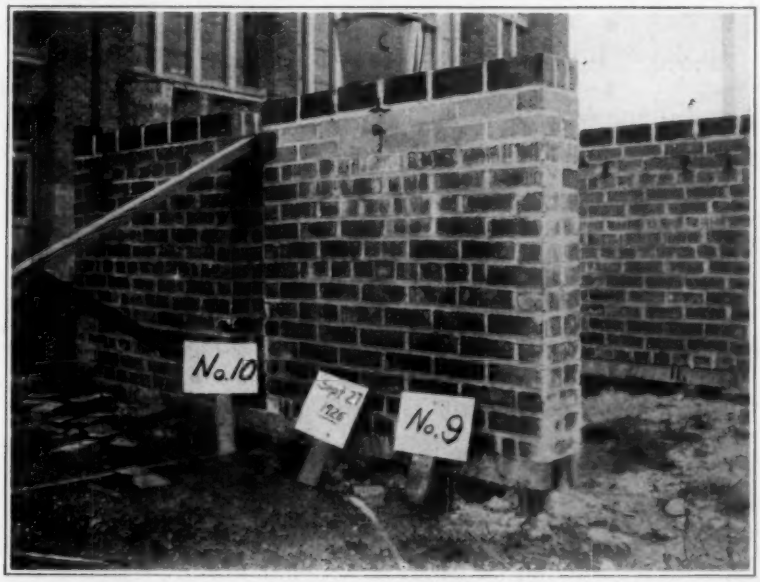

FIG. 6.—Panel 9 (right) was made of dry brick with lime-sand mortar, but the upper two rows were local cement brick, which released lime salts onto the lower red brick. Panel 10 was made of lime-cement-sand and dry brick with 5% barium carbonate in terms of the weight of Portland cement. It was a good panel.

Condensed History of the Panels

The first sixteen panels were laid during the first twelve days from April 30 to May 11, 1926. The work was delayed on account of rain.

11th Day, Panels 1 to 13 Inclusive The panels had not dried. Those which already showed scum were: Nos. 3, 5, 6, and 7. The scum was light on Panels 3, 5, and 7 but was very bad on No. 6.

16th Day Panels 3, 5, and 11 showed light traces of scum while Panels 6 and 7 showed very bad scum. The mortar of Panel 14 had white edges but this did not creep onto the brick surfaces. Alternating sunshine and rain until the thirtieth day with dry weather throughout the summer.

41st Day All panels were cleaned of mortar stain and scum with 10% muriatic acid and water.

42nd Day First artificial soaking with hose. Each panel was given two minutes soaking on all sides and top. They were wet down pretty thoroughly, but a large amount of water ran off immediately. After several days of drying, the only result was a light scum on Panel 8 in which sea water had been used. This washed off very easily.

53rd to 62nd Day (Bucket Soakings.) A bucket of water was poured slowly into the top cavity of each panel on four different days. However, it was found that most of the panels leaked badly and did not retain the water more than a few minutes. The soaking was not very thorough.

71st Day, July 10th Following a drying period from the 62nd day, observations were made of the condition of the panels:

Panel 2: 15 brick showed light streaks which were not bad.
" 3: 18 brick showed very white edges scattered irregularly over the wall. These were much whiter than the streaks on Panel 2.
Panel 5: 10 brick like Panel 2.
" 6: 25 brick like Panel 3. The rest were dirty white from old scum which appeared immediately after cleaning.
Panel 7: Universal cloudiness of old scum.
" 8: 23 brick were white and tasted salty. Universal dirty appearance.
Panel 9: 12 brick under the cement brick showed light streaks as in No. 2.
Panel 11: Trace of cloudiness on 6 brick.
" 12: " " " " 5 "
" 14: Light streaks on 8 brick.
" 15: " " " 7 "
" 16: " " " 7 "

73rd Day Second series of bucket soakings were given the panels for 10 days. This was followed by a drying period until July 29. The weather continued clear and warm.

90th Day The panels were in a condition similar to that reported July 10th save that Nos. 3 and 6 were worse. The majority of the brick had a white scum of a fuzzy nature. Number 8 with the salt water sand likewise showed some increase in amount of scum. Under the previous treatments, the Portland cement and salt water panels were the only ones which gave any serious tendency towards scumming. The soaking conditions were severe.

97th Day Start of siphon soaking. Method: A rubber tube siphoned the water in very small amounts from a bucket placed on top of each panel. The flow of water was regulated by a pinch cock and the panel kept continually moist. This procedure prevented the run-off down the side of the wall and consequently did not wash away the scum previously formed. It likewise gave a long soaking period of the mortar in certain spots. The bucket and siphon were moved back and forth across the panel. Buckets were filled twice a day. Soaking by this method was continued for 10 days.

108th Day The first light shower of the season.

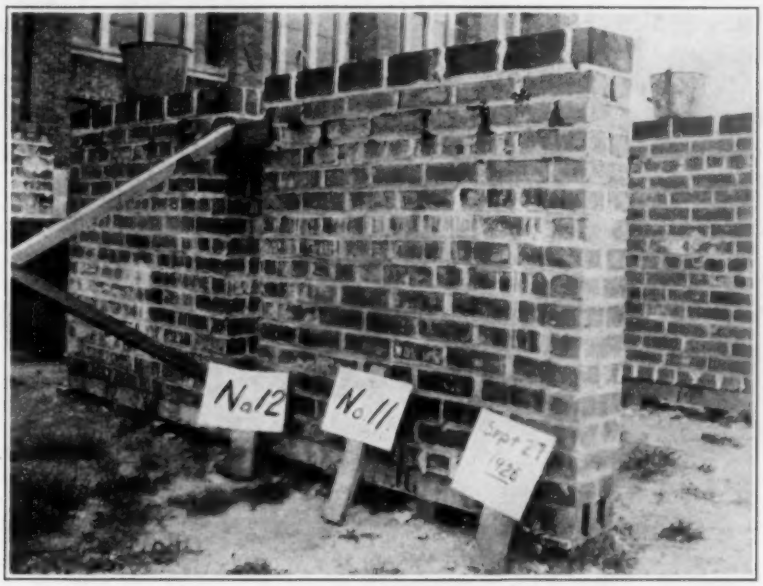

FIG. 7.—The composition of Panel 11 (right) was the same as Panel 10, but the mortar was mixed by machinery. The panel gave more scumming than Panel 10. In Panel 12 (left) the composition is the same as Panel 10 but the barium carbonate was soaked with the lime putty instead of mixing first with the Portland cement. Panel 12 was one of the poorest panels and showed a large amount of scum.

109th to 115th Day Panels No. 17, 18, and 19 were laid by University brickmason. Too much mortar was smeared over the surface. Showers on the 16th and 17th. Otherwise the panels had been drying since August 16th. Results:

Panel 1: Brick alone showed no scum.

" 2: A number of scum streaks came from two or more centers; probably buried lumps of calcium hydroxide which had not changed to calcium carbonate.

Panel 3: A uniform coating of white scum on almost all the brick. This was not streaked like the scum of Panel 2 but had a fuzzy appearance and spread over the surface. The fuzz is probably calcium sulphate from the free gypsum in the Portland cement.

Panel 4: A very small amount of streaked scum.

" 5: One small patch of the streaked scum and a slight amount of the fuzz scum.

Panel 6: Very bad fuzz scum. If the streaked type was present, it was hidden by the other type. Similar to Panel 3.

Panel 7: Very good. A small amount of fuzz scum, but comparatively clean.

Panel 8: Very bad sodium chloride (common salt) at the bottom. This type of scum was very soluble and had been washed off the top section in recent rains. It first made its appearance in the top courses. Apparently it could be removed from the wall if enough water was used. Some streaked scum was showing on the top courses. The mortar was very soft and was washed out from the joints and collected on the ground below.

Panel 9: Considerable streaked scum showing in three to four courses below the cement brick. The rest of the brick were clean save another type of scum which showed at the ends on the lowest courses.

Panel 10: Some streaked scum; north side almost free. Traces of fuzz scum. Fair.

Panel 11: Clean on the north side; some streaked scum on south side. Some of the chloride scum (?) at bottom ends. Origin unknown.

Panel 12: Considerable of the streaked type of scum in spots.

" 13: A few streaks of scum. Comparatively clean.

" 14: A number of spots of streaked scum, worse than 13.

" 15: One center of streaked scum. Trace of chloride (?) at bottom.

Panel 16: A few streaks of scum plus a little fuzz scum on one side.

Panels 17, 18, 19: These panels were laid with soaked brick and were not dry. Several brick in Panel 17 (barium carbonate) showed fuzz scum, but these were not seen in Panels 18 or 19. The hydroxide and chloride may be faster workers. All three panels were badly stained with mortar.

Tentative Conclusions to Date

(August 23, 1926) The prolonged soaking brought out a type of scum which is not often seen in lime mortars. This is a streaked scum which most often comes from a given point and streaks down the side of the wall. We would suggest that it came from a lump of partially hydrated lime in the mortar which because of its size remained for a longer time

in the lime hydrate form. The streaks have a filmy, glistening surface and are fairly permanent.

The barium salts seem to have counteracted the effect of gypsum in the Portland cement, but have not affected the lime hydroxide or the streaked type of scum. On the other hand, the fuzz scum which we believe to be the gypsum scum as it appeared in such large quantities in Panels 3 and 6 has not shown up to any appreciable extent in the cement-lime mortars.

FIG. 8.—Panel 13 (left) was made of dry brick with cement-lime-sand mortar and 5% barium hydrate. It was a good panel, giving only a small amount of the streak scum with excessive wash water. Panel 14 (right) has the same materials as Panel 13 but 3% barium chloride was used in place of the hydroxide. It likewise has given but a small amount of scum.

The salt water scum is still in evidence, but appears to be removable if enough water is used. However, it would be a bad scum for a long period of time in the ordinary wall.

117th and 118th Days Panels 17, 18, and 19 were cleaned before they were completely dry. Panel 17 with the barium carbonate showed some scum before cleaning; other two were not noticeable, but the mortar staining was bad.

The boxes of mortar brick were left in outside air till August 23 and then placed under water until August 30 and finally in outside air until January 5.

Siphoning Soaking Started for Second Time August 25

Sunshine and drying weather until Aug. 26th on which date it rained hard and steadily.

119th to 121st Day Showers and cloudy with little sunshine.

August 25 to September 20 Panels watered on days of no rain in this period. It rained six days, mostly from Sept. 15th to 20th which prevented the panels from showing maximum scum. A drying period until Sept. 27th.

Sept. 27 Pictures taken. Condition of panels was as follows:

Panel 1: This panel showed no scum. The panel beside No. 2 is one which was rebuilt from old soft common brick in storage at the University. These did not scum after setting in the panel but already had yellow kiln scum when received. The original brick of Panel 1 was relaid or repiled on adjoining timber.

Panel 2: Bad streaks of scum well distributed over the face of panel. Some fuzz scum near bottom ends.

Panel 3: Very bad, uniform, light-mottled scum over whole panel. Lower portions were particularly bad.

Panel 4: Comparatively good panel. A few light streaks and traces of fuzz scum on edges and corners.

Panel 5: Streaks on upper courses and fuzz on lower courses at ends of panel. Worse than Panel 4.

Panel 6: Very similar to Panel 3.

" 7: Several heavy but small patches of fuzz scum but no streaks.

Panel 8: Salt water scum all washed off except near the bottom. Besides sand and stains from the wash of soft mortar and sand, a few of the streaks showed.

Panel 9: Very bad streaks which were uniting under the cement brick. Fuzz scum showed badly on corners.

Panel 10: Few traces of fuzz scum with a few traces of streaks on one side. This was a good panel.

Panel 11: Bad streaks, worse on south side. Small amount of fuzz scum.

Panel 12: Very bad streaks and some fuzz.

" 13: A few streaks and light fuzz scum. A good panel.

" 14: Very few streaks on one side; one patch of fuzz scum on one side with a slight irregular fuzz scum on the other.

Panel 15: One small mass of streaks and a little light fuzz scum.

" 16: Similar to Panel 15.

Panels 17, 18, 19: All were clean save for scum left over from poor cleaning of mortar.

Conclusions

Best panels:	1–17–18–19.
Good:	4–10–13–14.
Poor:	2–5–7–11–15–16–9.
Very poor:	3–6–8–12.

Very irregular results. Panel 1 should have been good, but Panels 17, 18, and 19 had not had the long soaking action of the others. Why was Panel 4 better than 7 after a long period of soaking? Panel 11 should be equal to 10. Panel 12 whose barium carbonate was mixed

FIG. 9.—Panel 15 (right) has dry brick with cement-lime-sand mortar to which has been added 2% barium chloride and 3% barium carbonate. It is classed as a poor panel mainly because of a large central patch of calcium hydrate or carbonate, streak scum. The chloride-carbonate combination may be quite effective in reducing the sulphate scum. Panel 16 (left) has dry brick, cement-lime-sand mortar which contains Biber waterproofing material. The panel gave considerable scum and no effect of the waterproofing material was noted.

first with the lime putty instead of the cement might be a little worse at the start than 11, but the difference shown was rather great. If Panels 10 and 14 were good with the carbonate and chloride in separate panels, why should they not be good when the two were combined? High Portland cement in Panels 3 and 6 continued to be very bad and the salt water had affected the lime mortar so that it still scummed badly. Long and thorough soaking of lime will bring out a quantity

of streaked scum. It was apparent that these streaks were very irregular and were probably dependent on the leaching action of water as it passed through the panel. If the permeability of the panel was such that most of the water passed through one given passage which terminated on the face of the wall, that spot on the face would be badly scummed. Some of the panels may have had drainage channels which allowed the water to pass for the most part through the center of the panel and emerge at the bottom where the scum was not seen. It was apparent that in all of the mortar compositions tested, scum was developed if a large amount of water was permitted to seep slowly through the mortar and emerge on the face of the wall for evaporation.

FIG. 10.—Panel 17 (right) was made of soaked brick with cement-lime-sand mortar containing 5% barium carbonate. It gave good results except for one spot of the calcium hydroxide or carbonate scum. Panel 18 (left) was made of soaked brick and a similar mortar except 5% barium hydrate was used in place of the carbonate. It gave practically no scum until the winter rains brought out the abundant streak scums. Mortar spalling was found on both panels. See text.

The barium salts apparently helped in retaining the calcium sulphate but did not hold back a wash of lime hydroxide which may have come from undissociated lumps of hydrated lime.

Sept. 28 to Feb. 4 Rainy season in which the panels were never dry enough to show maximum scum. Panels were washed fairly clean during most of this period with the exception of the thickest scum on Panels 3, 6, and the streaks as on Panels 2 and 9. These were never entirely dissolved.

Results on Feb. 7 Panel 1: No scum.

Panel 2: Bad streaks of hard, white scum running down from mortar joints.

Panel 3: Entire surface covered with a dull white, mottled scum.

" 4: Fairly good; had a few streaks like Panel 2.

" 5: Few white streaks on one side, not quite as clean as Panel 4.

" 6: Same as Panel 3.

" 7: A fair panel with a few patches of streak scum near top of panel.

Panel 8: Similar to Panel 7.

" 9: Very bad white streaks just under layer of cement brick and extending the entire length of panel. This made a firm, hard crust on the red brick surface.

Panel 10: Fair panel, slightly mottled with dull white coating.

" 11: Fair panel, less scumming than on 12 but still very noticeable on one side.

Panel 12: Bad white scum on both sides.

" 13: Good panel. Few white streaks on bottom of one side.

" 14: Good panel. Few mottled patches on bottom of one side.

" 15: Fair panel though quite streaked in one spot on one side.

" 16: Bad scumming on both sides near bottom and close to top; streaked with hard white crust.

Panel 17: Good on one side except on the lower corner where a white hard crust had formed. Other side mottled with a light fuzz scum which was not permanent. Small spalls or flaking of mortar joints.

Panel 18: Badly streaked with white crust scum, also some light fuzz scum. The mortar was very badly pitted with spalling holes, worse than Panel 17.

Panel 19: A good panel with a few patches of fuzz scum, not very noticeable. Similar to Panel 18 in being badly pitted with spalling holes.

Conclusions

Except Panel 1, all showed scum. The streak type of scum (probably lime hydrate) was found on the panels with lime mortar and below the cement brick. Streaks are likewise found on practically all of the cement-sand-lime mortars but not in the cement-sand mortar. This indicated that severe soaking will bring out a bad type of scum from lime mortar alone. The high cement mortars in Panels 3 and 6 gave a different appearance, the scum was not concentrated in streaks but spread over all the brick. This type of scum started with the first drying out of the wall and continued indefinitely. It probably was calcium sulphate. A third type is the soft, thick fuzz type produced by the very soluble salts such as sodium chloride, sodium sulphate,

sodium carbonate, or perhaps the barium hydrate and chloride themselves. These are removed very easily by wind and rain but present a bad appearance while they last.

March 28 A rainy period followed the brief drying spell of early February. The efflorescence was washed from the walls. While it rained often enough and the humidity was high enough to keep the brick work from showing the scum, yet very little water penetrated the walls, to bring out salts later. Thus a preliminary drying

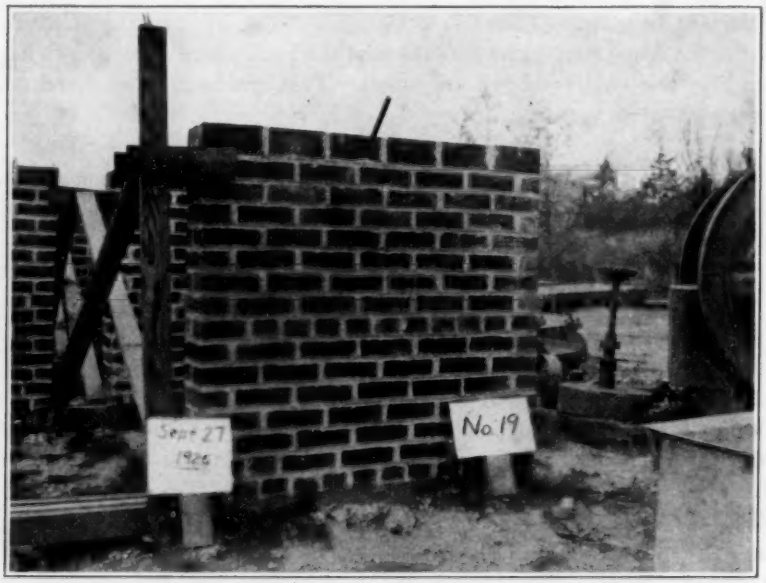

FIG. 11.—Panel 19 was made of soaked brick, cement-lime-sand mortar containing 3% barium chloride. It has remained practically clean throughout the whole testing period. The mortar shows some spalling.

spell followed by a washing will give a short though effective efflorescing and prevent a longer display of salts at the beginning of the dry summer weather. However, the drying period in February was not sufficient to remove the water from the north and east sides of buildings and these are now showing more scum than the south and west sides which blossomed forth in February.

April 1 A second brief drying spell, sufficient to bring out scum on the north and east sides of the buildings but very little change in the panels. Rain till April 7.

April 27 Panel 20 was constructed with soaked brick and a sand-cement mortar containing 2.5% barium hydrate and 2.5% barium carbonate in terms of the Portland cement. Panel 6 of the

same composition and soaked brick, but without the barium salts gave the worst drying-out scum of the series. To date (August 26, 1927) Panel 20 has only given traces of scum after several hard rains and two ten-day soaking periods. This indicates that the barium salts were at least retarding the scum from Portland cement.

Hardness and Strength of Mortars

The lime-sand mortars without cement are the softest. But salt water even reduces this low strength to such an extent that the joints are washed back from the face of the panel by the water used in the soaking tests. The lime-sand mortars are cut very easily with the knife. The cement-lime-sand mortars with and without barium salts form a medium hard group. The small addition of barium salts did not make enough difference in the mortar hardness to be detected by scratching with the knife. The hardest group was composed of the mortars of cement and sand alone. They were practically knife hard.

Preliminary strength tests were made of a 1:3 cement and sand mixture and a cement hydrated lime-sand mixture to which small additions of barium carbonate were added. The former showed a 5.9% loss in the 28-day tests while the mortar with the barium showed a 12.2% gain in strength. This work will be continued.

Lumps of Lime in Lime Putty and Hydrated Lime

Small lumps may often be found in slaked and hydrated lime. If they are the unburned cores of the original limestone blocks which have not been transformed into quick lime, no trouble will occur, for they are inert to water. But if they are lumps of slightly overburned or hardened lime which slake very slowly, they may be a source of scumming in walls which are well saturated. When lime slakes in water it forms a very finely divided or colloidal suspension which will even float or remain in suspension longer than many clays. Freshly carbonated lime may likewise be carried in the water streams in a finely divided condition.

For this reason lime is one cause of the first or temporary scum which may form on a wall when it first dries out, especially if the wall has been laid with wet brick or during rainy weather. While the colloidal slaked lime particles will be held back by the fine capillaries of the ordinary fired clay brick, they will be carried with the water through the comparatively coarse pores of the mortar joints, cement brick, and cast stone, to the surface of the wall. If the water is sufficient to trickle down the wall in a small stream the lime hydroxide will be deposited as streaks on the surface. If the water is not sufficient to flow down the wall but can only creep onto the adjoining brick surfaces by capillarity,

the hydroxide will not streak but spread in a rather hard translucent crust over the adjoining surfaces. After a short contact with the air, the hydroxide absorbs carbon dioxide from the atmosphere and changes to the more insoluble calcium carbonate and its activity is gone.

From the experience with the panels and with other tests in the laboratory, it is believed that the scum from lime mortars alone is due more to the bodily carrying of the colloidal calcium hydroxide as a suspension rather than to the hydroxide in true solution.

Further Laboratory Tests to Produce Scum

Red brick were placed on edge in two inches of saturated solutions of (1) common salt, (2) calcium sulphate (pieces of plaster of Paris), and (3) calcium hydroxide. The common salt solution rapidly crept up through the pores of the brick and formed a thick white crust over the whole surface exposed to drying. This is the typical illustration of a very soluble salt evaporating from a porous surface. After a month's soaking, the brick immersed in the calcium sulphate solution has only shown a very faint scattered scum which would hardly be noticed in a wall. This experiment is to be repeated with other types of calcium sulphate than set plaster of Paris, such as raw gypsum and finely pulverized plaster. The calcium hydroxide likewise did not produce an adequate scum on the top brick surface, but did form a translucent scum like very thin ice on the surface of the surrounding solution. In this case there was no wash of water upward and the pores were too fine to permit any colloidal slaked lime to pass up with the water.

A second experiment was tried to note the effect of water washing down from above. Four brick were laid on each other with the faces in the same vertical plane. A burette containing a solution of common salt was placed above the brick and the solution permitted to drip onto the upper surface, and work its way downward. The upper brick rapidly developed a thick white fuzz scum on all sides similar to the former experiment. But concentrated, filtered solutions of both calcium hydroxide and sulphate failed to produce any but the faintest of scums. A $\frac{3}{4}$-inch lump of lime which had refused to air-slake after standing for over a year in the laboratory was next placed close to the edge of the top brick and the water allowed to drip onto this in such a way that any excess would be carried over the edge. A long thin streak similar to those which had previously appeared on the panels started to form in a few hours. Nevertheless, a like experiment tried with a piece of set plaster of Paris neither produced streaks nor more than a faint trace of any other type of scum. This will be repeated with other types of calcium sulphate and calcium hydroxide lumps.

This indicates that the streak type of scum originates with the slaked lime suspension and not from common salt or some types of gypsum. There also must be an excess of water to cause a slight wash down the surface and the lime hydrate or carbonate suspension must come out of the mortar joints where the pores are large or holes are to be found. This idea accounts for the temporary scum which appears on the first drying of the wall, but after that, air should penetrate the masonry, change the calcium hydrate to carbonate, and stop further action. This happens to the bulk of the mortar with which the carbon dioxide of the air can readily come in contact. But any lumps of partially slaked lime will remain uncarbonated for months and possibly years before changing completely. In some of the old cathedrals of the Middle Ages built with very thick walls, it is reported that the deeply-buried, lime mortars are not completely carbonated at the present time. Hence, lumps of lime even in an eight-inch wall will be sources of a very durable type of scum if a large amount of soaking water is permitted to come in contact with them. And from our experience with a reputable slaked lime putty, we believe that this is a common experience with a large amount of brick work. However, it must be remembered that our panels received an internal soaking not often experienced by brick walls.

Panel 21 was constructed with hydrated lime mortar and sand. The hydrated lime was screened through a 20-mesh sieve and mixed with sand in the proportion of 52 pounds of lime and 390 pounds of sand. The brick were soaked in water before laying. The results to date (August 26, 1927) have been very good. The panel was erected April 28, 1927, and has received several good rains and two artificial soakings of ten days each. Some scum has appeared but only a few small streaks formed by streams of water out of the weak places in the mortar are noticeable.

It has been suggested by H. R. Goodrich[14] that diatomaceous earth, added to lime mortars may react with the calcium hydroxide and form a more stable calcium silicate. From Benson's experience[12] with the solubility of the calcium silicates of Portland cement, it is probable that this will hydrolyze if sufficient water is provided, but should retard the efflorescence if the silicate is formed.

Another defect originating from lumps of lime was noted in Panels 17, 18, and 19 laid at a different time from Panels 1 to 16. The lime putty was from a different batch. Numerous spalling pits were found on all three panels. Since they were first noticed after a series of nightly

[14] Celite Products Company.

freezings, it was thought to be due to freezing. But at the bottom of many of the pits or spalls a lump of soft lime can be found. Such action is similar to the spalling of fired clay brick which contain lime pebbles, and freezing is not necessary to produce the spalling. The spalling of the mortars may then have been due to the expansion of the lime on carbonating or hydrating or to the local expansion of ice from a well-soaked lime-hydrate particle. In either case it is apparent that lumps of lime should be avoided in mortar mixtures.

Preliminary Analyses of Scum

Preliminary analyses have been made by James R. Lorah of the Department of Chemistry, but these are being checked at the present time by a more elaborate series of tests and will be reported at a later date. The determination of these common elements is an everyday procedure, but it is a more difficult task to ascertain their method of combination. The lime magnesium, barium, and sodium may be present as hydroxide, carbonate, chloride, or sulphate and it is no easy matter to determine the exact salt combination. Qualitative methods of analysis are of small value because all the scums with the exception of those containing barium salts, contain practically the same compounds and the amount of salt can not be estimated with any degree of accuracy.

While the scum on a wall may show considerable discoloration, the actual weight of removable white material on the surface is small and only minute samples can be secured. These are usually too small for a definite quantitative analysis. Leaching with boiling water for a short time is being compared with leaching with cold water for a long period of time. Some salt determinations have been made of the brick fired to different degrees of vitrification in comparison with Portland cement and cement brick. The cement brick contain about seven times the soluble salt content of the well-fired clay brick. The reason that these cement brick and those grades of artificial, cement stone which are made by the damp, tamping process, are sources of such large amounts of scum, is that they contain very large communicating pores and water penetrates them very easily to drain onto brick work below.

Examples of Scum and Efflorescence in Seattle

The month of January, 1927 was very wet, with heavy rains accompanied by wind. Everything porous was saturated. The period of February 7 to 15 was dry. The temperature dropped slightly below freezing at night but the days were warm and bright. Buildings all over Seattle blossomed forth with white scum.

(1) Engineering Hall, University of Washington campus: This is an old building faced with light gray, rather porous, dry-pressed brick. A leaky spout flooded a large portion of the rear wall and this portion showed bad scumming. Large broad, window sills covered with a thin layer of cement gave a chance for the brick work below to be saturated and these showed scum. However, no scum was noted where the wall was protected from actual soaking, even though subjected to the beating action of wind and rain.

(2) Mines Hall: Five years old. Steel frame work, concrete shell, covered with buff and polychrome face brick and terra cotta trim. This building has been leaking internally from the gutters or from rain seeping in through the concrete, producing scum on the interior walls; the scum is concentrated enough to lift the paint from the concrete and covers the walls with white efflorescence on all sides. It now shows white scum on the outside, mostly on the corresponding outside walls just below the roof level. We believe that the salts come from the concrete back of the brick work. A few patches of scum are seen below the terra cotta window sills on the lower floors, and more is noted on the brick work of the exposed balustrades capped with terra cotta at the entrance.

(3) Education Hall: About three years old and of similar construction to Mines Hall. Different face brick and different terra cotta trim. Rather bad scum under window sills and other places where there is an excess of water with a possible opportunity to soak in rather deeply. The projecting portions of the brick work show the worse scum.

(4) Anderson Hall: About one year old. Face brick of same make as Education Hall with cast-cement, stone trim. A very beautiful building very badly disfigured with scum. The drying period at this time was not sufficient to dry more than the south and west walls. The majority of the scum lies under the cast stone sills or other ornamental features which could be well soaked. This is very similar to Panel 9 of the test series. The face brick have scratched surfaces which prevent the formation of streaks, so common on the smooth red faces of the panels. The glass window panes are actually streaked with scum from the cast stone used above in the window trim.

(5) Meany Hall: The massive entrance balustrades capped with a thick coating of concrete and faced with light gray, dry pressed brick, scum badly each year. This may be due to the combination of cement above and the large amount of water which penetrates its flat upper surface.

(6) Bagley Hall: The parapet just below the gutter line scums each year. This is an old building faced with terra cotta and the same brick used on Engineering Hall. The scumming is not universal but in spots and is probably due to leakage at these places.

(7) Model Brick Home: Less than one year old. Common brick facing wall. Barium carbonate was used in the mortar. This wall has not scummed. The rear basement wall was laid in mortar without barium and it scummed slightly in spots when first dried out.

(8) Renton Library: Made of impervious, smooth, red, face brick. Even these walls showed some scum which cannot be attributed to the brick.

(9) Laher Auto Spring Company: Free standing walls at entrance, red face brick showed bad scumming. Walls are unprotected.

(10) University Herald Building: Small building faced with buff-colored, eastern Washington brick in black mortar. Probably constructed in fall of 1922. Badly scummed following soaking and freezing of winter of 1923. The analysis by Sullivan, U. S. Bureau of Mines is: CaO 2.7, MgO 1.6, CO_2 26.8, SO_4 17.3, Al_2O_3 and Fe_2O_3 1.9, SiO_2 6.1, and a large quantity of sodium.

(11) Broadmoor Wall: This is a garden wall of smooth faced, red, glacial clay brick with cement-lime mortar to which barium carbonate was added on the job. Some scum was found on the wall proper but the worst case was noted on the interior of the arched entrance which is capped with a heavy ornament of cast stone. The scum extended from the cast stone in heavy, hard encrusted streaks which gradually became more powdery

or fuzzy near the base. The wall was erected in the winter of 1926 and dried out for the first time in the following spring. Qualitative analyses made of both the hard and soft varieties of scum showed sodium, lime, sulphate, and carbonate. This is a clear case of scum leaching from the cast stone down over the protected brick work. The lime hydroxide is carried over the brick surface while the other more soluble salts of the sodium variety can travel through the brick themselves in solution.

(12) Recent Seattle Schools: Two recent buildings were built with 5% barium carbonate in terms of the Portland cement mortar. These did not show scum during the brief drying period in February, 1927. Another without barium of similar brick and construction did show scum.

General Conclusions and Summary

(1) Since water is the only carrier of soluble salts, the best preventive of mortar or wall efflorescence is the absence of water. It is well to avoid soaking porous brick any more than necessary and to permit the wall to dry out thoroughly before it is given its final cleaning. All brick work should be protected from leaking drains, cappings, sills, etc. While a heavy rain driven by the wind will penetrate, a light rain will have very little effect in producing scum. Sufficient water in contact with all our common mortar materials for a sufficient length of time will cause scum.

(2) Portland cement and its products, concrete, artificial stone block, and cement brick carry a large quantity of easily removed salts such as calcium hydroxide, calcium sulphate, and others which, up to the present time have not been retained by the so-called waterproofing compounds. These Portland cement products have large continuous pores through which dissolved salts and even calcium hydroxide in suspension can pass out to adjoining surfaces and produce discolorations.

(3) Scum was produced with all of the mortars used in the present panel tests. Sufficient water and time for soaking was all that was necessary. The first and worst scum in the beginning was rich cement mortar. Salt water replacing fresh water in the mortar also gave a quick scum which probably in a long period of time will gradually be removed. It, however, produced a very weak mortar and should be avoided. The scum from lime mortars was only produced by large quantities of water in long contact with the interior of the wall. The type of scum produced from lime alone has not been seen by the writer on walls in use save those in contact with fresh cast stone and therefore it is not believed to be a serious factor for ordinary brick work. However, it is better to use lime putty which contains no lumps of overburned or other slowly slaking portions which carbonate slowly and offer a continual supply of calcium hydroxide. Hydrated lime, because it has been screened, appears to offer a lime mortar which is freer from this defect than the common water-slaked lime.

(4) Barium carbonate has proved effective in preventing the temporary efflorescence of calcium or magnesium sulphates. Barium carbonate will not prevent the scum from lime hydroxide suspensions from Portland cement, cast stone, or other cement products, or from uncarbonated lumps of lime in lime mortars. It will not prevent the scum from salt water. While the more soluble barium salts act more rapidly, yet rapid action may not be necessary. Barium chloride, reacting with calcium sulphate produces the soluble calcium chloride which will produce a scum itself. Barium hydroxide may be preferable because it produces calcium hydroxide or a form of lime putty. The extra cost of barium hydroxide has not yet been justified.

(5) Barium salts only act on one type of efflorescing salts. Other compounds may be found to take care of the remainder. A universal solution of the problem may lie in the development of a waterproofing compound which will not only fill the voids or surface voids of the mortar, but also of the brick and cement products.

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DISCUSSION ON "KILN CONSTRUCTION"[1]

By T. W. Garve: Such papers, giving data from actual operations on various types of kilns, are most welcome and we are glad to note that the T-bottom type (or cross-head flue type) has given the best results.

It is apparent, however, from Fig. 5* that the T-bottom alone fails to give a uniform heat distribution. There is a zone with hard fired ware only above and along the cross-head flue (it scales about 7½ feet wide in the center) followed along each side by a zone of medium fired brick (about 5½ feet wide on each side) with the remainder toward the kiln walls containing nothing but light fired ware.

It is evident that this should be the case where the gases enter the cross-head flue through its top instead of sides and where under-floor flues are lacking.

Kilns of the cross-head flue type have been designed and built for the past fifteen or twenty years but we have always used deeper under-floor flues to permit of better heat distribution and pull from the ends of these flues. By using 9-inch feather walls there is no danger of tilting. Such deeper flues will also permit of real sand pockets within the open flues below the ports of the feather walls. We prefer the semi-perforated floor, *i.e.* alternating open and blind flues for brick. Only with such blind flues are we enabled to obtain circulation, uniform heat distribution, and control. The ports from the open floor flues to the blind flues can be made of the same size. Then we put loose bricks in these ports or slots, first two bricks, then one brick in the center and none in the outer port. For more port holes along each flue we use split brick sizes. Figure 1 does not show such brick; instead we have spaced the outer ports closer than the inner ports which has the same effect.

Should the draft not be uniform over the floor, it can be weakened where needed and strengthened elsewhere. Though we do not know of any such changes having been made afterward, they are possible and in a careful study of kiln operation as Mr. Lyon has made, some adjustment may be desirable. It is also possible to adjust the blind flue openings into the cross-head flue.

The draft should be choked to a minimum in the floor to check and spread the heat, consistent with watersmoking requirements. A fully perforated floor does not give this essential choke unless the slots are covered by the setting. We aim to set the bricks squarely on the floor blocks thus leaving the slots fully open and there is a channel through-

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[1] J. B. Lyon, "Kiln Construction. An Efficient Round, Downdraft Kiln for Firing Refractories," *Jour. Amer. Ceram. Soc.*, 10 [3], 185–204 (1927). Received May 25, 1927.

* *Loc. cit.*, p. 191.

out the kiln area between the setting. We have only to determine the minimum size of slot which gives the best result to have constant floor draft conditions.

One factory built eight kilns after our plans, except for some reason the open-floor flues were directly connected with the cross-head flue which made the blind flues useless. The gases would naturally take the direct route and there was no circulation under the floor. The company

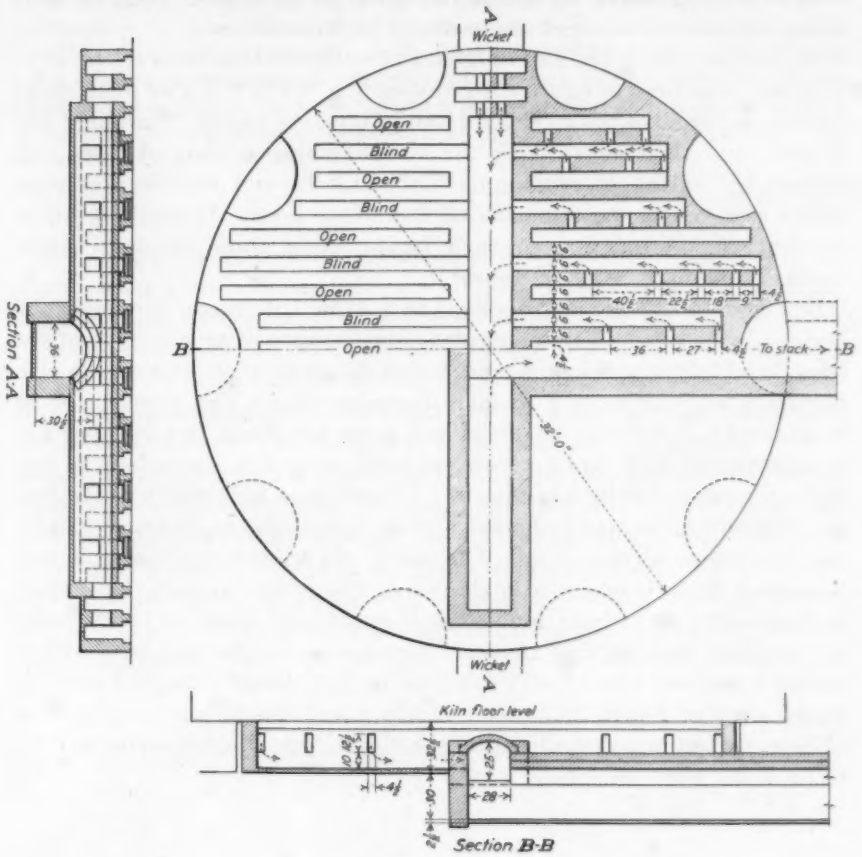

FIG. 1.

decided to build four more kilns and it was a question which plan to adopt. They decided to follow the regular plan making use of the blind flues and after getting these kilns into operation, the results were so much better that they changed all bottoms of the old kilns to the blind flue plan. It is the circulation directly under the floor that adds greatly to the value of the blind flue plan.

It is to be hoped that experiments and observations will be made on a type of kiln as above outlined which should improve conditions. We have a total depth to the bottom of the main draft flue of only 5 feet 5 inches for a 32-foot diameter kiln against about 6 feet 3 inches for the 30-foot diameter kiln of Mr. Lyon. An excessive depth is a detriment in most instances, if nothing worse. Not mentioning other features, we wish to add that we have always provided means for expansion of the floor all around and of the feather walls but we have never used a 6-inch trench all around to which there might be objections.

Instead of basing the size of flues and outlets on the area of the kiln, it seems to us best to figure the cross-section of the stack or main draft flue by any or all of the methods given in Lovejoy's book "Burning Clay Wares" and then figure back the various cross-sections of flues and outlets by means of rectangular-circle tables and equilization pipe tables as given in the appendix of the above book. It would seem to us that the verification of such fundamental data through actual operation should be very desirable.

Our main draft flue is equivalent to a 35-inch diameter pipe which is ample for the kiln. The rectangular cross-sections of each branch of the cross-head flue is equivalent to a 26-inch diameter pipe, and two of such pipes are equivalent to a 35-inch diameter pipe. The inlets into the cross-head flue are 9 by 10 inches and there are about 16 such openings or sixteen $10\frac{1}{2}$-inch pipes. Now, 16 such pipes are equivalent to one 34-inch pipe or a little less than the 35-inch pipe with which we began, but it is advisable here to be shy rather than ample to be assured of an equal pull from all directions. The pull at the wickets is stronger in any case since there is no right angle turn. The ports through the feather walls should figure about double due to turns, and when we finally come to the floor slots we find that the semiperforated bottom (with alternating open and blind flues) will give us just about enough 1-inch by 9-inch slots or 3-inch diameter pipes to equal the 35-inch original size of pipe, taking into consideration the closing-up of one-quarter to one-third of them by the setting.

A PETROGRAPHIC STUDY OF SOME SLAGS FROM BOILER FURNACES[1]

By Samuel J. McDowell and H. C. Lee

ABSTRACT

Observations are based on a microscopic study of the effect of slags, particularly those of an Illinois coal, on refractories. A mineralogical relation is shown between the slag and the refractory used. The principal phases present in a cooled slag are: (1) a plagioclase feldspar, (2) magnetite or hematite, (3) mullite with iron oxide in solid solution, (4) glass. The so-called "interface" between slag and refractory is largely crystalline upon cooling and consists principally of mullite which, surrounded by the slag, has grown from fine needles in the refractory to larger ones. In high alumina refractories where diaspor is present, the stained interface is much thicker and grains of corundum are formed. This zone of crystallization may be conducive to spalling. The effect of slags on various refractories is discussed.

Introduction

The Columbus Station of the Bureau of Mines undertook a laboratory study of slagging in boiler furnaces in 1926. The work was done under a coöperative agreement with a special research committee on boiler furnace refractories of the American Society of Mechanical Engineers and the Fuel Division of the Bureau of Mines, the latter being in charge of the field investigation.[2] The laboratory phase has for its ultimate goal the determination of the fundamental mechanics of slag erosion. Petrographic examinations were made with the hope that a knowledge of the crystalline constituents of the slag and the associated refractory material could be correlated with the service behavior of the refractory. This paper presents the results of the petrographic studies of specimens from a furnace at Chicago burning Illinois coal from Christian County and a furnace at Cleveland burning coal from Belmont and Jefferson Counties, Ohio. The composition of the coal-ash, as taken from

Table I

Analyses of Coal Ash

	From Chicago furnace (per cent)	From Cleveland furnace (per cent)
SiO_2	43.5	42.3
Al_2O_3	18.6	19.9
Fe_2O_3	19.3	29.2
CaO	8.0	2.8
MgO	0.7	0.7
SO_3	7.7	1.5
TiO_2		0.8
K_2O, Na_2O	3.1 (by difference)	2.8 (by difference)

[1] Published by permission of the Director of the Bureau of Standards, U. S. Department of Commerce. Presented at the Annual Meeting, American Ceramic Society, Detroit, Mich., February 1927. (Refractories Division.) Received September 9, 1927.

[2] This work is being continued at the Columbus Station of the Bureau of Standards.

the furnaces, is given in Table I.[3] Conditions in the furnaces from which the slag and refractory specimens were taken were carefully observed by the field investigators and have been reported.[4]

Slagging Produced by Kincaid Illinois Coal in a Chain Grate Stoker-Fired Boiler Furnace

Thin Slag Coating

When Illinois coal is used with fireclay refractories at temperatures above 1427°C (2600°F), as found in the boiler furnace at Chicago, the resulting slag is very fluid and is found as a thin coating varying from $\frac{1}{16}$ to $\frac{1}{8}$ inch in thickness. Back of this is the so-called "interface" where slag and refractory are intimately associated and chemical reactions take place altering each. The zone is about $\frac{3}{8}$ inch thick and when cool shows a well-crystallized structure which gradually blends into unaltered refractory.

Microscopic examination of a brick shows the outer coating of slag to contain a plagioclase feldspar approaching anorthite ($CaO \cdot Al_2O_3 \cdot 2SiO_2$) in composition, iron oxide in different stages of oxidation varying from magnetite (Fe_3O_4) in treelike growths to hematite (Fe_2O_3), some mullite ($3Al_2O_3 \cdot 2SiO_2$) with iron oxide in solid solution, and a large amount of glass.

At the interface, where the slag and refractory meet, mullite is the prominent mineral and apparently is developed during heating. The crystals originally present in the fireclay refractory as tiny microscopic needles have, in the presence of the slag, developed and grown into the slag as well-formed and relatively large crystals.

In a refractory containing cyanite the particles of cyanite are inert and no "seeding" or mullite growth from them is noted. However, where slag is present at the interface, large growths of mullite needles oriented similarly to those in the calcined cyanite grains proceed from

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[3] It has been shown by R. A. Sherman and W. E. Rice, "Refractories Service Conditions in Furnaces with Chain Grates," *Mech. Eng.*, **48** [11], 1115 (1926), that the analysis of the material carried up by the gases is not the same as the ash from laboratory burned samples or the ash remaining in the furnace grates. The apparatus for correctly collecting this gas-carried material had not been developed by the field investigators during the test on the boiler furnace burning Illinois coal and we can only judge the characteristics of this gas-carried material from that of other coals which were studied later. It seems probable that it consisted of a larger portion of glass containing iron in solution, some plagioclase feldspar corresponding to andesine (Ab_3An_1 to Ab_1 to An_1), and some fluffy unidentified material.

[4] R. A. Sherman and W. E. Rice: Stokers and Furnaces (June 1926) "Report of Prime Movers Committee of the N. E. L. A." See footnote 3 above. See also R. A. Sherman and E. Taylor, "Service Factors Governing the Slagging of Boiler Furnace Refractories," *Jour. Amer. Ceram. Soc.*, **10** [8], 629 (1927).

these grains as is shown in Fig. 1. This growth of mullite at the interface may or may not be desirable. From a solution standpoint it should aid in resisting further slag action, but the growth of large crystals may cause a tendency toward spalling if the furnace is cooled to a temperature below that at which slag and refractory are rigid.

Thick Slag Coating

When, due to a lower furnace temperature, a thick slag is built up on a fireclay refractory, the outer surface of the slag is removed from contact with any source of mullite except that inherent in the slag itself. Microscopic examination shows that in this case a plagioclase feldspar (with a composition between bytownite and anorthite) and iron oxide, varying from magnetite to hematite in degree of oxidation, appear as the principal crystals. As the body of the refractory is approached, mullite becomes the predominant crystalline phase. The less abundant feldspar minerals present are too fine and too full of iron inclusions to be absolutely identified, but are presumed to vary from bytownite to anorthite as do those found in the slag alone. At this interface between slag and refractory, mullite with iron in solid solution is practically the only crystal present. The flint fireclay and grog particles detached from the refractory and surrounded by slag show evidence of slow solution and are present as rounded stained grains. An examination of many thin sections also shows the presence of a small amount of an undetermined mineral of high indices of refraction.

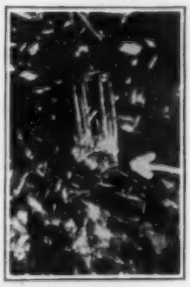

FIG. 1.—Needles of mullite growing from grains of calcined cyanite.

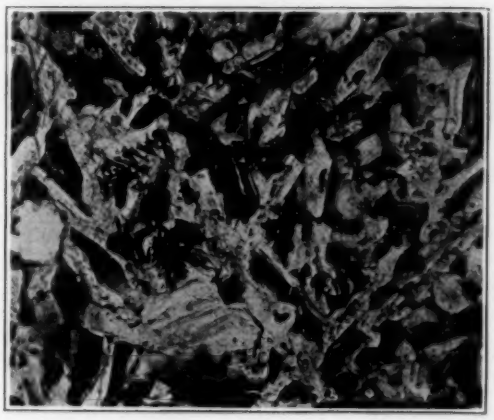

FIG. 2.—Sections through a stalactite; feldspar crystals are quite large and seem to show resorption.

The common occurrence of the mineral mullite in the slag and refractory indicates its importance. More complete information on the mullite-iron oxide solid solution diagram might aid materially in explaining slag erosion.

Long Stalactites from the Arch

The stalactites which develop on the arch tile, where the conditions are such that they do not drip rapidly, form favorable places for further slag deposition at

high temperatures, and are probably composed almost wholly of slag. The stalactites are rather dense in the center and porous on the outside and, probably because of the length of time during which they were maintained at high temperatures, show a very marked crystalline structure. There is a small amount of interstitial glass between crystals of magnetite and of a plagioclase feldspar which is practically pure anorthite. The feldspar crystals which predominate are quite large and seem to show resorption. A photomicrograph of a section through one of these stalactites is shown in Fig. 2. The light-colored materials are feldspar crystals while the dark-colored portions are magnetite and dark glass.

FIG. 3.—An arch block (inverted) on which drips have constantly formed and dropped off.

Short Drips from the Arch Tile Figure 3 shows an arch block where, presumably due to a higher temperature, these drips have constantly formed and dropped off. Here the predominant mineral is mullite with some magnetite in the interstitial glass. The mullite is greenish in color; the indices of refraction are much higher than those of mullite[5] and almost as high as those of sillimanite. In order to further study this material, crystals of the mineral were separated from the slag and heated to cone 28 (approximately 1615°C or 2939°F). When magnetite "sweated" out of some of the crystals as they were slowly cooled, the crystal indices were lowered and the mineral was, therefore, presumed to be mullite with iron in solid solution.

The difference in character of the drips illustrates some of the changes which take place due to continued slag action on the refractory. The presence of mullite and the absence of feldspars indicate that the composition is largely influenced by the dissolved refractory.

Slagging on High Alumina Refractories Some refractory mixes were made having a higher alumina to silica ratio than fire clay and subjected to slag action in this boiler furnace.

[5] N. L. Bowen and J. W. Greig, "The System Al_2O_3–$ASiO_2$," *Jour. Amer. Ceram. Soc.*, **7** [4], 238 (1924).

These consisted of mixtures of diaspor ($Al_2O_3 \cdot H_2O$), cyanite, and clay. The effect of slag on these pieces is quite interesting. As far as physical appearances go, there is little if any glassy slag at the surfaces. The slag is duller and more crystalline. It has apparently soaked into the refractory and formed a deep stained area. Crystals of mullite and sometimes corundum can be seen in protected cavities in the brick.

FIG. 4.—A corundum crystal which has been resorbed by the siliceous slag with the formation of mullite.

A microscopic study of the relations between the slag and these refractories shows that the outer surface contains mullite as the predominant crystalline phase. Adjoining this area is one containing both mullite and corundum, the relative amounts of mullite and corundum varying with the alumina content of the refractory. The corundum, like the mullite, occurs in sizable crystals and is found in groups unevenly distributed through the mass. These groups probably owe their origin to altered grains of diaspor. The borders of the crystal clusters are often rounded and apparently show resorption with associated areas of mullite in well-developed crystals. Figure 4 shows a corundum crystal which has the appearance of having been resorbed by the siliceous slag with the formation of mullite. The grain itself is corundum while the fringe at the edge is mullite.

TABLE II

PENETRATION OF ILLINOIS COAL-ASH SLAG. CHEMICAL COMPOSITION OF REFRACTORY AND MINERAL CONTENT OF SLAG

Al_2O_3:SiO_2 ratio (mol.) of refractory	Per cent porosity of refractory	Slag penetration (inches)	Mineral composition at interface	Character of interface
1:1.285	36.77	$\frac{1}{8}$	Mullite throughout	Vitreous
1:1.175	35.60	$\frac{1}{8}$	Mullite predominates Corundum present	Semivitreous
1:0.952	34.50	$\frac{3}{16}$	Mullite predominates Corundum present in patches	$\frac{1}{16}$–$\frac{1}{8}$ in. of stain
1:0.944	36.65	Irregular penetration $\frac{3}{8}$–$\frac{5}{8}$	Corundum greater than mullite	$\frac{1}{16}$–$\frac{1}{8}$ in. of stain
1:0.765	33.80	Irregular penetration $\frac{1}{2}$–$\frac{3}{4}$	Corundum predominates	$\frac{1}{4}$–$\frac{1}{2}$ in. of stain
1:0.742	35.57	$\frac{3}{4}$	Corundum predominates	Very little stain; not glassy

Table II shows the variation in slag character with refractory compositions. All of these refractories were tested in the same boiler furnace. Spalling often occurs in these refractories in the stained area where corundum has formed abundantly. The plates of corundum are not as strong structurally as the interlocking needles of mullite formed in fireclay bodies at the slag contact plane. Increased spalling in these refractories may be due to weak structure more than to application of great stresses, although the coefficient of expansion of corundum is almost twice that of mullite and the difference between the coefficients of expansion of these materials and the glass itself probably tends to set up strains when the temperature is lowered and glass and refractory become rigid.

Slagging Produced by Use of "Pittsburgh Coal"

This coal was used in the chain grate, stoker-fired furnace studied at Cleveland, Ohio.

It will be noted that in this ash the iron is much higher and the lime content much lower than that of the Illinois coal. Under oxidizing conditions the slag from this coal is not as severe in its erosion as that of the Illinois Coal. Under reducing conditions, however, it slags badly.[3]

A microscopic examination of various sections shows a somewhat similar condition to that in the Chicago furnace. More magnetite and less feldspar are present, as would be expected from the ash analyses, and the mullite shows more iron oxide in solid solution; otherwise the observations on the effect of Illinois coal-ash and fireclay refractories are equally true for this ash.

Conclusions

The following relations appear to be brought out from the petrographic examination of slagged specimens most of which came from a boiler furnace burning Illinois coal.

(1) In the cooled slag itself, plagioclase feldspar and iron oxide are the dominant mineral phases. The particular feldspar and the type of slag depend on furnace conditions and the refractory.

(2) Where such a slag is in contact with a fireclay refractory the so-called "interface" or the zone between slag and refractory consists largely of mullite, with iron in solid solution, surrounded by glass. This suggests possible causes of spalling through the formation of minerals of different coefficients of expansion. Strains from this source would probably only be set up when the temperature is low enough for the slag and refractory to be rigid, but this might occur each night when the fires were banked.

(3) There seems to be a certain sequence to slag attack. That portion of the coal ash carried by the gases strikes the refractory and deposits

thereon a slag from which a plagioclase feldspar and iron oxide would crystallize if cooled. This material at furnace temperatures reacts with the refractory to produce a slag of different composition which gives mullite as the primary crystal phase.

(4) The slag promotes growth of small mullite needles in the refractory, forming large needles in the contact zone between slag and refractory.

(5) If the high alumina refractories (prepared from clay, cyanite, and diaspor) are used, the types of slags produced differ and a deeper-stained area is formed as the alumina content increases. Mullite is prominent on the outer surface, but becomes mixed with corundum plates as the refractory is approached. Rather large crystals of both corundum and mullite appear in the stained area.

Acknowledgment The writers wish to express their appreciation to G. A. Bole, former Supervising Ceramist, U. S. Bureau of Mines, under whose direction the work was carried out; to W. J. McCaughey, head of the Department of Mineralogy, Ohio State University, for his aid in the microscopic phase and its interpretations; to R. K. McBerty, coöperative engineer of the American Society of Mechanical Engineers, for his suggestions and aid in the work; to L. E. Geyer, Bureau of Standards, for the photographs; to R. A. Sherman and W. E. Rice, field investigators of the Fuel Division, Bureau of Mines; and to P. Nichols, Fuel Engineer, Fuel Division, Bureau of Mines, Pittsburgh, Pa., for general coöperation.

FIRING OPEN TERRA COTTA KILNS WITH GAS[1]

By W. O. Owen

ABSTRACT

Experiments conducted with a small kiln in firing terra cotta without the use of a muffle giving satisfactory results, the large kilns at this plant were equipped for gas firing, the muffles being removed. The equipment for gas firing is described and alterations made in the kilns are explained. The general operation of the kilns is discussed. Savings obtained are enumerated. The consideration of gas as a fuel in the ceramic industry is recommended.

Introduction

The writer was assigned to approach the Kansas City Terra Cotta Company in May, 1926 to secure a fuel survey of the plant. Mr. Sheffield agreed to turn over to the gas company a small kiln of one-ton capacity, for experimental firing.

The kiln was of the round muffle type with three fire boxes; part of the heat going through flues under the floor, up the muffle, and out of the stack, and part going directly up the muffle and out of the stack.

The gas firings on this kiln were successful from a standpoint of ware but the cost was higher than coal.

The gas furnished by the Kansas City Gas Company is of about 1000 net B.t.u. per cubic foot with the following general analysis: CO_2, 0.9%; O_2, 0.4; CH_4, 65.7; C_2H_6, 21.5; CO, 0.7; and N_2, 10.8, and at the following rate:

First	400 cu. ft. or less	$0.75
Next	1,600 " "	.09 per hundred
Next	48,000 " "	.085 " "
Next	250,000 " "	.08 " "
Next	1,200,000 " "	.065 " "
All over	1,500,000 " "	.04 " "

The air required for complete combustion is 10.82 cubic feet per cubic foot of gas.

Experiments with Open Firing

From all the information we could get, it appeared that a muffle was absolutely essential to successful firing of terra cotta. Due perhaps to our ignorance of the problems involved and to our experience with other heat applications, we were firmly convinced that by using gas as a fuel we could do away with the muffle. In other words, we believed that gas could be so completely burned and controlled in the fire boxes that no possible harm could result to the ware by allowing the products of combustion to come in contact with it.

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[1] Presented at the Annual Meeting, American Ceramic Society, Detroit, Mich., February, 1927.

To play safe as far as possible, a piece of ware sprayed with standard red was placed outside the muffle allowing the flue gases to come in direct contact with it. After firing, this piece was carefully examined for defects and none were found. The next step was to take the muffle out of the kiln and to make a firing with the entire kiln. This was also successful. The final test was made with devil's red and gold, and though the kiln was not properly designed to get the exact temperatures, top and bottom, required by this enamel, on a whole the ware was good, the flue gases having no bad effects.

Further experiments were carried on with a larger kiln and being thoroughly convinced that the gas would have no ill effects on the ware, the Kansas City Terra Cotta Company gave the gas company an order to equip all their kilns for gas.

Equipment of Large Kilns

Five commercial kilns were equipped, all of the usual type of round muffle kilns. The sizes of these kilns were as follows:

No. 1 Round Kiln
Diameter 15 ft. 7 in.
Height 16 ft. 0 in.
Fire boxes 6
Rated capacity 30 tons

No. 2
Diameter 8 ft. 7 in.
Height 9 ft. 10 in.
Fire boxes 6
Rated capacity 5 tons

No. 3
Diameter 17 ft. 9 in.
Height 16 ft. 10 in.
Fire boxes 10
Rated capacity 30 tons

No. 4
Diameter 19 ft. 7 in.
Height 17 ft. 6 in.
Fire boxes 13
Rated capacity 50 tons

No. 5
Diameter 28 ft. 4 in.
Heigth 17 ft. 6 in.
Fire boxes 20
Rated capacity 90 tons

The ware in these kilns was generally fired to Seger cone No. 5 down or 2246°F. We found that when the coal fires were first lit the temperature would jump to about 400°F and from then on the temperature curve would be a jagged line, rising and dropping as more coal was added or the fires were cleaned. There was a definite demarcation between high and low fire, when the kilns showed red inside. There was no pyrometer control. Two firemen were employed on each shift, extra men being called in as needed.

Equipment It was decided to equip these kilns with the same general type of gas-burning equipment. We used Surface Combustion low pressure inspirator sets; the general principle of the operation of these is as follows: the principal parts of this inspirator are a zero governor and a venturi throat. The zero governor is connected to the venturi throat and that gas flowing at line pressure to the

governor is reduced to zero pressure. The operating energy is furnished by the pressure of air which in turn is controlled by the air cock. The tapered approach, restricted throat, and expansion cone of the venturi cause the air to change from static to velocity and back to static head again. Ports are drilled through the throat into the gas chamber at a location near the restricted throat, the high velocity of the air passing through this narrow section which is utilized to draw in or inspirate the gas. In the expansion cone the gas is mixed thoroughly with the air and the mixture is converted to a pressure head suitable for delivery to the burners. The amount of gas which a given pressure of air will draw in is controlled by a set screw. The valve which inlets from the gas chamber to the venturi will open under different pressures of air.

The air necessary for combustion was supplied by two G.E. blowers directly connected to motors. With this equipment a constant oxidizing or neutral atmosphere may be attained, and, due to the ease of control, a steady temperature gained thus doing away with the quick gains and losses in temperature produced by coal.

The kilns have been equipped with an indicating pyrometer, with a thermocouple top and bottom. This is valuable in allowing the firemen to start evening up the kilns before the temperature gets too high.

Kiln Alterations The stacks were done away with inside the kilns, and the floors lowered to the level of the fire boxes; the muffle was torn out and a bag wall built completely around the inside of the kilns, the top of the bag wall being between the second and third bearing.

One burner was placed in each fire box, the front of the fire box being bricked up leaving only two openings, one for the burner nozzle and an air slot at the bottom. The burner nozzles were of cast iron with a mechanical construction to keep the flame on the burner, combustion taking place in a short space. On each kiln, with the exception of No. 5, two burners were placed in one of the fire boxes. This extra burner fed a tunnel built on top the floor which helped mature the ware in the center of the kiln.

On No. 5 which is 29 feet in diameter, three of these tunnels were used and in addition a stack was built inside leading to a central stack on top the kiln. The bottom of this stack was checkered, the theory being that part of the flue gases will go through the tunnels maturing the ware in the bottom bearing at the center. Other gases will rise over the bag wall to the crown and draw down to the bottom and out of the stack.

The general operation of these kilns is as follows: the dampers are left wide open; about three burners are lit bringing the temperature up gradually, a great amount of secondary air passing through the slot in the fire box and into the kiln. As the kiln rises in temperature more

burners are lit and turned low until about the sixth hour when the last burner is lit. If the bottom is very far behind at this point, the dampers are shoved in slightly. This puts some pressure on the top of the kiln, forcing the heat to the bottom.

We have found by experience and test that all the carbon in the clay is oxidized at about 1350°F and up to this point we are careful not to damper the kiln too much. From this point, however, we can run the kiln under pressure if need be, but after adjusting air burners for an over-ventilated flame, we find that the percentage of over-ventilation takes care of itself. As the temperature rises and more gas is burned, the over-ventilation automatically decreases.

Savings Obtained

Our time of firing is about one-half as much as the time with coal, a thirty-ton kiln being fired in about 55 hours; the rate of cooling is more rapid, and there has been no trouble with cracking. The labor required is only one man for each shift.

At the present time it requires about 10,000,000 B.t.u. per ton of ware or 10,000 feet of our gas.

The capacity of the kilns has been materially increased by the removal of stacks and muffles.

Due to the nondeteriorating effects of gas on fire brick, a much cheaper grade of brick can be used.

The advantages of doing away with the muffle are manifold. The costs of repairs and replacements of the muffle were high. Leaky muffles sometimes ruined a kiln of valuable material and in addition the fuel and time lost in heating up and cooling all of this excess brick work was quite an item.

Future Development

There could be a great fuel saving made with kilns of a different type. We think a small tunnel kiln of 5- to 10-ton capacity, fired direct with gas to take the place of the round kiln, would be a great fuel saver and would be more easily controlled.

The methods of manufacturing gas have shown great improvements. Better burning equipment scientifically designed has been developed.

The gas companies are taking a great interest in new developments, more attention being given to rates for different classes of industries.

In view of all these facts we think the ceramic industry will do well to consider the possibilities of gas, the ideal fuel.

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SOME INVESTIGATIONS OF A NEBRASKA CLAY[1]

By Arthur James Rymes

ABSTRACT

A brief review of the literature on the fluxing action of different metallic oxides on clays is given. A series of mixtures of what seemed to be the "dirtiest" clay of four obtained, with varying amounts of pure calcium carbonate which passed a 150-mesh screen was made up into briquets and physical properties were studied on the unfired and fired specimens. The firing was done at four temperatures, 1800°F, 1900°F, 1950°F, and 2000°F. Properties observed were fusion point, drying and firing shrinkage, crushing strength, and porosities of the fired specimens. The principle of the Armstrong volumeter used for porosity determinations is explained. The results obtained indicate possibilities of materially improving qualities of brick now being produced from so-called ordinary clays but only after a very considerable amount of further work is done.

Introduction

The work outlined in this study was suggested to the author as the result of some investigations made for one of the brick manufacturing plants in Nebraska while working with Professor Frankforter. George E. Condra, Director of the State Conservation and Soil Survey was of much assistance in offering certain geological data required.

There are many limestones in Nebraska. These differ considerably in chemical and physical properties. Some deposits are of sufficiently good grade for use in the sugar industry, for lime production, and for Portland cement manufacture. Many are of inferior grade and remain unworked. A little limestone is used locally for building purposes and a considerable tonnage is crushed for concrete and ballast. The geological proximity of these beds of limestone to some of the clay and shale deposits, suggested the idea of using the limestone along with the clays or shales to produce a better grade of brick and tile. It was thought that certain physical properties of the finished products might be improved, even when some of the so-called poorer grades of clay were used. In beginning the work an attempt was made to study the effect of calcium carbonate on the physical properties of the brick produced from an ordinary clay yielding a common grade of red brick. As is usual, the problem developed some complexities and it was possible to complete the initial phases of the work on one clay only.

Historical

A study of the literature afforded considerable information, some closely related to the matter in hand, but much of it only remotely associated with this study.[2]

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[1] Received September 12, 1927.

[2] See bibliography at the close of this article.

In 1868 Richter formulated a law covering the fluxing action of different metallic oxides on clays. This work was confirmed in 1895 by E. Cramer. This law may be outlined as follows: chemically equivalent quantities of magnesia, ferrous oxide, soda, and potash exert the same influence in lowering the fusibility of a clay. General results seemed to show that this law was applicable only under conditions of high temperature and for very small amounts of fluxes in the clay. Ludwig stated in a survey of Richter's work that the law was a special case of the general law of dilute solutions and therefore applied only to very dilute solutions, that is, clays with small amounts of fluxes, and not brick clays or glazes. Mellor stated that the agreement of a very limited number of empirical observations with the dilute solution law appeared to be due more to chance than to order. He regarded the law as inapplicable and the analogy with dilute solutions as invalid in view of the large amount of contradictory evidence. The oxides mentioned above do act as fluxes to a certain extent and disregarding their relative fluxing power, which seemed to vary to extremes under different conditions of temperature and composition of clay, calcium carbonate might be expected to exert considerable fluxing action on an average clay.

The lowering of the melting point, meaning here complete fusion, is not of advantage in the commercial production of brick and tile, save that information regarding the melting point of a clay is useful in predicting whether a certain clay would be valuable for making fire brick. The temperature at which vitrification begins and the temperature at which it is possible to completely vitrify a brick without deformation or melting, is information of the greatest importance to the brick manufacturer. Therefore knowledge of the effects of any reactions which might take place between lime and clay during vitrification and before complete fusion, would be data which would decide whether the addition of limestone to a clay would improve the brick produced. It is data of this type which has been sought in this study.

Ries stated that the expulsion of carbon dioxide leaves calcareous clays porous up to the beginning of fusion. If the temperature is higher than that required for driving off the carbon dioxide, some of the particles begin to soften and reaction begins between the lime, iron oxide, alumina, and silica, resulting in the formation of very complex silicates. This reaction tends to destroy the common iron red color, yielding a buff color in the resulting mass. R. Rieke did considerable work on the effect of calcium carbonate on kaolin and he stated that the addition of limestone decreased the shrinkage and increased the porosity of burnt samples. The effects were more marked as the proportion of limestone was increased, save at relatively low

temperatures, at which the carbon dioxide had not been completely expelled. The most easily fusible mixture according to Rieke, was one corresponding to $Al_2O_3 \cdot 2CaO \cdot 2SiO_2$, equivalent to 46.3% of calcium oxide by weight.

The Illinois State Geological Survey, *Bull.*, No. 9, in discussing the work of Bleininger, Nauss, and Rieke, stated that the work of these investigators showed clearly that chemical alteration and reactions may take place long before vitrification and fusion begin. Further, each mixture had its own peculiar pyrochemical behavior and as mixtures become complicated, the deductions drawn from simple mixtures are found to be true only in very small part. The difficulties encountered in attempting to trace the effect of lime on such complicated mixtures as shale was clearly shown.

From a study of the literature and from data obtained in preliminary experiments, the decision was reached that data relating to the effect of lime on pure kaolin would not be applicable to a study of ordinary clays and shales. Until more complete knowledge of the states of combinations of the various elements in clays is available and until more complete information can be found relative to the chemical behavior of the complex silicates encountered in them, a problem of the type in hand can be studied only by empirical observations, aided by predictions based on general chemical information.

Experimental

The various limestone-clay mixtures were fired at different temperatures and the resulting bricks were compared with specimens made from the untreated clay. Differences in the fusion temperatures, drying contraction, firing shrinkage, crushing strength, porosity, and color were noted.

The samples of clay used were obtained from the pits of the Yankee Hill brick plant about three miles southwest of Lincoln, Nebraska. At present this plant is making an ordinary grade of common red building brick. Four different samples were obtained, corresponding to the four different zones exposed. These zones exist generally without sharp boundary lines. There is often more or less mineral matter other than clay substance mixed through the different zones. Sample 1 was a yellowish material, quite free from matter other than clay; Sample 2, a dirty brown material with a small amount of material other than clay substance in it; Sample 3, a reddish-yellow mottled shale; and Sample 4, a red mottled shale. Both of the latter were free from matter other than clay substance. Samples 1 to 4 are in order from the upper to the lower zones. As already noted, the initial phases of the work on one sample only have been completed and what follows is the report of

this work. Because Sample 2 appeared to be the "dirtiest" or lowest grade clay, it was selected for the first work. After being dried in the air free from acid fumes for several days, it was then ground in a Braun sample grinder and the ground material screened on standard Tyler sieves. Before grinding, the sample was lumpy and quite firm, though not at all hard. The data in Table I show the per cent by weight of the sample held on each mesh screen.

TABLE I

Mesh size	Per cent	Mesh size	Per cent
20	4.8	90	1.1
30	22.9	100	1.7
40	6.9	120	0.2
50	22.9	150	0.4
60	trace	200	7.1
70	"	Passed 200	30.6
80	"		

The ground sample, after thorough mixing, was stored in glass-stoppered bottles for use as needed.

Ultimate chemical analyses were made on all four samples and Table II shows the data obtained on Sample 2.

TABLE II

Constituent	Per cent
H_2O	3.37
Org. and vol.	3.13
SiO_2	71.81
MnO_2	trace
Fe_2O_3	4.36
Al_2O_3	12.39
CaO	1.32
MgO	0.93
Na_2O:K_2O	2.68

The sodium and potassium were determined by difference.

It was not possible to make appreciable use of the chemical analysis but it did help some in outlining the lime treatment. It appeared doubtful if a rational analysis would have been of much greater value. A very great amount of disagreement was noted in the literature, authorities differing regarding methods of making and interpreting rational analyses.

For firing the clay and limestone-clay mixtures, a special type of furnace was constructed. The idea was to obtain a uniform temperature within the furnace with a relatively high temperature maximum. This furnace consisted of an ordinary muffle, such as is used in the Denver Fire Clay Company's Case muffle furnace No. 14, mounted inside a heavy firebrick wall. The mounting was such that the flame passed beneath the muffle and was forced back around, through and above the muffle by a baffle. The small hole in the back part of the top of the muffle was considerably enlarged to allow a free flow of the hot gases. The chimney opening in the back part of the top of the furnace wall

was directly above the opening in the muffle. A door was fixed in the front part of the furnace wall, aligned directly with the open front end of the muffle and about six inches from it. There was a small opening in the door itself where temperature readings could be taken without removing the main door. This small opening could be closed with a plug. This opening had very little effect upon the temperature of the furnace and it was not necessary to hurry the readings unduly in order to prevent a temperature drop in the working zone of the furnace. This furnace is illustrated by Figs. 1 and 2.

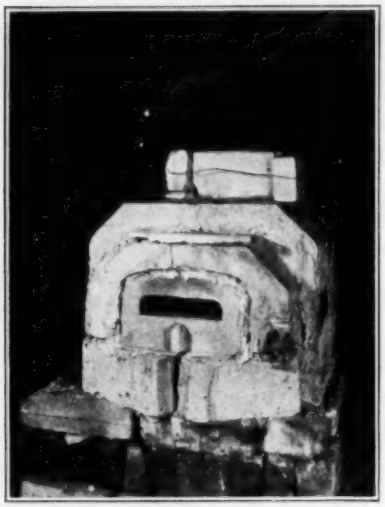

FIG. 1.

But little time was required to bring this furnace up to its maximum temperature, in fact great care had to be exercised to prevent a too rapid increase in temperature. The gas used was a typical carburetted water-gas under a pressure of about one and one-half to two pounds per square inch, the air pressure being furnished by a rotary blower giving a pressure of approximately three to four pounds. The mixing valve of the regular Case muffle furnace was used. It was possible to maintain a very uniform temperature (the maximum being about 2500°F) throughout the muffle and, by using only the front half, a variation of not more than 15° was observed at the top, bottom, middle, and either side of the muffle at temperatures ranging from 1800°F to 2400°F.

In addition to the home-made gas-fired muffle, an electric muffle furnace was used for work where temperatures not higher than 2000°F were required for not more than three hours at a time. This furnace was manufactured by the Electric Heating Apparatus Company of New York.

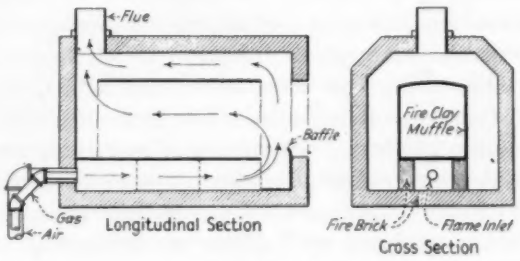

FIG. 2.

Temperature measurements were made using Seger and Orton pyrometric cones, a Fery Radiation pyrometer, a Leeds and Northrup Optical pyrometer, and a

direct reading base-metal couple Tycos pyrometer having a range of 1800°F. All instruments had been recently calibrated.

Realizing that the time element is a very important factor to be considered in determining the fusing points of substances where the melting point is partly dependent upon chemical action, the furnace was run on a definite time-temperature schedule. The rate of firing was approximately 10°F per minute up to a temperature of about 2000°F. From this point up to the melting point range, the rate of heating was about 5°F per minute. This rate of firing was much more rapid than brick plant practice, but because of the small test cones, it was not too rapid for proper firing up to the fusing point range. This schedule saved much time over the long runs of plant practice.

In determining the melting points of the several mixtures, different methods of handling the materials were tried. After considerable experimenting, it was decided that a cone similar in dimensions to the standard Seger cone was the best form for the samples under test. These clay cones were easily made in a simple wooden mold and were readily observed in the furnace.

In the experimental work, chemically pure calcium carbonate was used as the source of calcium oxide, rather than the impure form in limestone. This carbonate was very finely divided, all of it passing a 150-mesh screen.

It was recognized that the evolution of carbon dioxide during the firing of a clay or a limestone-clay mixture, had a marked effect upon the porosity of the finished brick and information about the action was desired.

It was known that particles of calcium carbonate or limestone in sizes exceeding approximately 2 to 3 mm. in diameter, will always cause "blisters" during burning if on or near the surface of the brick. Even when buried deeper in the brick mass they tend to accelerate the disintegration and weathering of the brick. The larger the particles, the more serious the disintegration.

If the particles of burned limestone buried in the brick become wet, the expansion often causes serious cracking of the brick. A porous brick might tend to allow more moisture to reach the lime, but at the same time the porosity would tend to prevent fracture due to expansion.

It was recognized that magnesia had a marked effect upon the firing of clays. Many of the Nebraska limestones are dolomitic, with very appreciable amounts of magnesium oxide. This phase of the study of limestone-clay mixtures will be taken up at a later date.

Table III shows the results obtained in determining the melting points of the clay and lime-clay mixtures. In these mixtures the amount of calcium carbonate added is recorded in percentage by

weight of calcium oxide in the mixture. As this clay showed no more than a mere trace of soluble calcium salts or calcium carbonate, the lime added was the only free calcium oxide available, that in the clay probably being fixed as some type of silicate.

TABLE III

Composition of specimen	Degrees F
Raw clay	2346
2 % lime	2270
4 " "	2239
10 " "	2126
12 " "	2134
15 " "	2162
20 " "	2270
30 " "	2340

Figure 3 is the curve plotted from the above data. These data, and all recorded in this paper, are the averages of a large number of determinations. It is possible, but improbable, that maxima or minima points would appear in the curve with percentages of lime other than those studied. The percentages recorded were selected after much experimenting with other proportions. Those selected were believed to be representative of what might be termed small, medium, and large proportions.

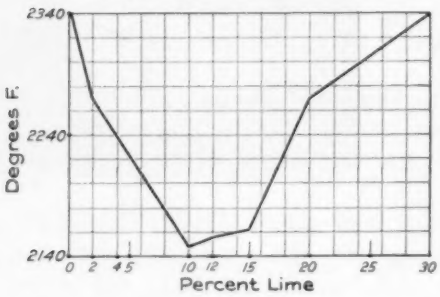

FIG. 3.

Small briquets were prepared for the determination of porosity, contraction, and crushing strength. These briquets were approximately 1 by 1 by 2 inches in size. They were made by hand-pressing the moist clay into metal molds. An attempt was made to use the same amount of pressure on each sample. The specimens were air-dried for about twelve hours and then oven-dried at 212–220°F for ten to twelve hours. The samples were fired at the rate of 10°F per minute until the desired temperature was reached and then held at this point for three hours.

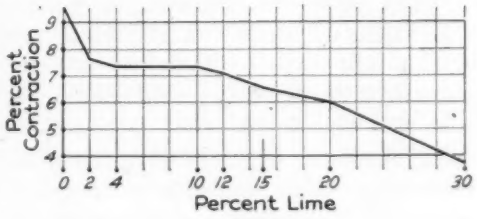

FIG. 4.

The two lower temperatures noted in the following tables and figures were selected because they represent common temperatures encountered in brick manufacturing practice. The two higher ones were chosen in

order to determine the effects of slightly higher temperatures on the samples under test.

Determinations of the amount of linear contraction of the small briquets were made by careful measurements with vernier calipers. The per cent of contraction on drying was based on the dimensions of the "green" undried brick. The per cent of shrinkage on firing was based on the dimensions of the dried brick. In Table IV appear the data obtained on the several specimens prepared. A negative contraction in this table and figure means an expansion and it will be noted that several samples expanded appreciably.

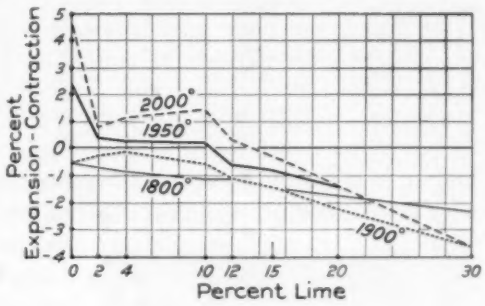

FIG. 5.

Figure 4 shows the curve for the drying contraction and Fig. 5 carries the curves for the firing shrinkage and expansion.

TABLE IV

Composition of specimen	Drying contraction 212–220°F	Firing shrinkage 1800°F	1900°F	1950°F	2000°F
Raw clay	9.57	−0.57	−0.57	2.29	4.86
2 % lime	7.66	−0.60	−0.34	0.34	0.65
4 " "	7.43	−0.86	−0.26	0.26	1.14
10 " "	7.43	−1.14	−0.52	0.26	1.43
12 " "	7.14	−1.14	−1.14	−0.57	0.34
15 " "	6.54	−1.43	−1.43	−0.85	−0.34
20 " "	6.00	−1.71	−2.28	−1.43	−1.43
30 " "	3.71	−2.28	−3.71	−3.71	−3.71

The crushing strength of the fired specimens was determined on an Olsen machine. The Civil Engineering Department of the University courteously cooperated in carrying out these tests. The usual mechanical precautions were observed in preparing the test specimens. The areas of the test samples were carefully measured with vernier calipers. Table V gives the data obtained in these tests and Fig. 6 carries the curves plotted from the data. It will be noted that data for the 30-% lime-clay mixtures are not given. It was found that a 30-% mixture really did not yield a brick, even when fired at 2000°F. The resulting briquets were simply masses of easily crumbled material consisting of a mixture of lime, clay, and some fused particles.

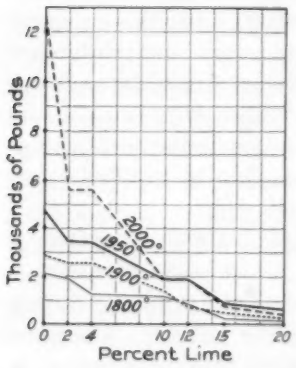

FIG. 6.

Porosity was determined by means of Armstrong's volumeter, modified as appeared desirable for this work. Kerosene was used as the liquid to displace the air in the pores of the test briquets in order to avoid any solvent action on the mineral matter. This kerosene

TABLE V

Composition of specimen	Pounds per sq. in. 1800°F	1900°F	1950°F	2000°F
Raw clay	2064	2812	4770	12700
2 % lime	1910	2540	3440	5600
4 " "	1290	2540	3400	5600
10 " "	1210	1240	1800	1800
12 " "	800	770	1800	1800
15 " "	260	470	870	840
20 " "	210	250	580	430

had a low vapor pressure at ordinary temperatures and trial runs with a manometer in the evacuating line showed the volatilization loss was so small as to produce only negligible errors. Each briquet was held under the kerosene for 15 minutes at a pressure of 16 cm. of mercury. Authorities differ greatly as to the time required to fill the pores of a brick completely with a liquid. From a number of experiments, it was decided that any pore space unoccupied by kerosene after the 15 minutes' evacuation, was so small that it could be safely disregarded. It was true that long continued evacuation did cause a slightly greater amount of kerosene to be absorbed, but this amount produced only a very slight difference in the percentage of porosity and was disregarded. Since each briquet was exhausted under similar conditions, all determinations were comparable and errors due to unfilled pores could be left out of consideration.

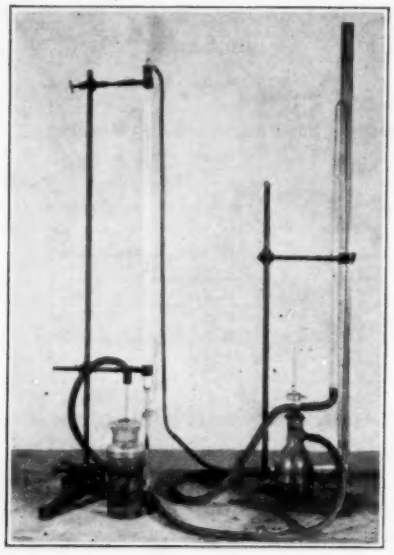

FIG. 7.

The volumeter or porosimeter consisted of a 100-cc. burette, a 500-cc. wide-mouth glass-stoppered bottle, a short piece of quarter-inch glass tubing and a short piece of glass capillary tubing. A hole was drilled through the side of the bottle near the bottom. The glass tube was bent at right angles and one end sealed into the opening in the side of the bottle. To the upper end of this tube the burette was sealed. The glass stopper was drilled and the capillary tubing sealed

in so that the lower end was flush with the inside or lower end of the stopper. A stopper with a glass tube was fitted to the top of the burette and connected by suction tubing with a vacuum pump. Upon opening the stop-cock of the burette and connecting the pump, it was possible to raise the kerosene to any desired height in the burette. With the pump connected to the capillary tubing and the burette stop-cock closed, it was possible to evacuate the air held in the pores of any sample submerged in the kerosene. The stopper of the bottle was reground to an accurate fit and lubricated with a trace of glycerine. Figure 7 is a photograph of the porosity measuring apparatus and Fig. 8 is a drawing of the apparatus minus the pump and manometer.

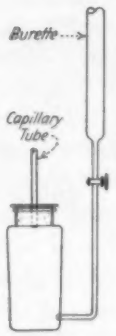

FIG. 8.

Porosity determinations were made as follows. Sufficient kerosene was introduced into the apparatus so that it could be allowed to rise to a calibration mark on the capillary tube in the glass stopper, at the same time leaving enough in the burette to reach near the 90-cc. calibration mark. The first burette reading was then made, the vacuum pump attached, the burette stop-cock opened, and enough kerosene drawn up into the burette so the bottle could be opened. Ample kerosene to completely cover the briquet was left in the bottle. A briquet was then carefully placed in the bottle, the stopper replaced, and the vacuum pump connected to the capillary tube. The briquet was exhausted for 15 minutes at the pressure already noted. At the end of this time the vacuum pump was disconnected, the burette stop-cock opened and the kerosene allowed to drain into and through the bottle to the calibration mark on the capillary tube. The second burette reading was then taken. The difference in the two readings gave the volume of the solid matter of the briquet plus any pores into which the kerosene could not penetrate. This difference was termed (*A*). The stopper was removed after the kerosene level had been lowered in the bottle by again drawing it into the burette. The briquet was then carefully removed. Next, the stopper was replaced, the burette stop-cock opened, and the kerosene again allowed to rise to the calibration mark on the capillary tube. The third burette reading was then made. The briquet upon removal was lightly touched with a soft cloth to remove only the surface kerosene and not absorb it from the body of the specimen. After withdrawing the kerosene from the bottle, the latter was opened and the soaked briquet introduced. The kerosene was again allowed to rise to the mark on the capillary tube and the fourth burette reading was made. The difference between the third and fourth readings termed (*B*) was the volume of the briquet plus the absorbed kerosene. (*B*) minus (*A*)

equaled the pore space measured. This was termed (*C*), and (*C*) divided by (*B*) was the volume percentage of pore space in the briquet. Table VI gives the porosity data on the several specimens.

TABLE VI

Composition	1800°F	1900°F	1950°F	2000°F
Raw clay	33.4	28.0	23.0	23.0
2 % lime	34.5	34.0	28.0	26.5
4 " "	36.6	36.3	34.3	28.8
10 " "	46.0	42.5	40.8	30.9
12 " "	47.4	48.0	44.0	43.2
15 " "	52.5	51.0	51.8	49.3
20 " "	58.9	55.5	55.5	55.9

Figure 9 carries the curves plotted from the above data.

Discussion

A study of the fusion point curve indicated that the addition of lime lowered the melting point of the clay, and the lowest melting mixture was one containing approximately 10% lime. By melting point is meant that temperature at which the specimen first exhibited fluidity to a noticeable extent, such as the falling of the small cone of the material. The more correct term would be melting range. It is evident that a mixture such as a clay, would not have a sharp melting point. It is theoretically possible for a clay to consist of a single compound after complete fusion. It is also possible that some sort of a eutectic might be formed, but apparently neither of these conditions actually exists. Recognizing the variations obtainable in determining the melting point of a clay, due to chemical action and rate of firing, and recognizing that the melting point does not necessarily indicate the heat-resisting properties of a clay under varying conditions, nevertheless, when samples are fired under comparable conditions, one is enabled to secure a classification in regard to the melting points. The melting point curves presented show that the addition of lime to the particular clay investigated, lowered its melting point of a minimum associated with a lime content of 10%. Further additions to lime raised the melting point. Chemical tests showed the presence of free lime, much of which remained as a fairly rigid mass. It is possible that sufficiently high temperatures might cause the formation of compounds rich in chemically combined lime. This excessively high temperature would probably

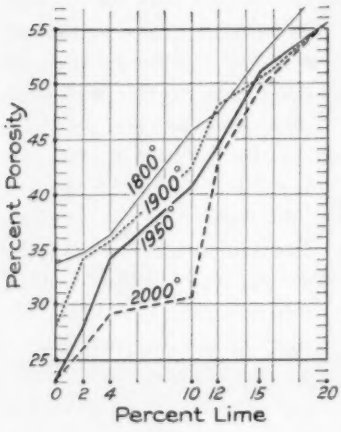

FIG. 9.

not warrant its cost on a commercial scale, even if a good brick substance was produced. Lime caused the points at which vitrification first takes place and that at which fusion is complete to draw closer together for mixtures near the 10- and 12-% lime-clay ratio. If fired to complete vitrification, clays with a relatively high free lime content (10- and 12-% mixtures for example) will fail or soften comparatively suddenly at or near this temperature of vitrification. Obviously a clay or mixture of this type might cause great difficulty in a kiln due to sudden fusing or "squatting" of the pile. All but the top layers of brick in a kiln would be subjected to a considerable mechanical load which would hasten the "squatting" of materials at or near their softening point. A continuous kiln in which the great weight of masses of brick was not involved might overbalance this undesirable effect. It was observed that cones of raw clay and various lime-clay mixtures behaved in the manner just outlined.

Some clays shrink a great deal on drying. From a study of the drying contraction curve (Fig. 4) it is noted that the addition of calcium carbonate decreased the drying shrinkage to an appreciable extent. This curve approximates a straight line, more so than the graph actually indicates, since the coördinates selected were more significant than the accuracy obtainable in the measurements. The decreased drying contraction was due, at least partially, to the fact that the mixtures with calcium carbonate required less water to make them sufficiently plastic to mold. The addition of the carbonate lowered the plasticity or workability of the clay. With 20% carbonate the plasticity was low but the mass could be worked without particular difficulty. There was no distortion in drying the raw clay or any of the mixtures. If the raw clay briquets were dried too rapidly, numerous small cracks appeared but they apparently caused no trouble during firing. No cracks were observed in the lime-clay mixtures, even when dried very rapidly.

Table IV gives the data for the firing shrinkage and Fig. 5 shows the curves plotted from this data. Calcium carbonate decreased the burning contraction considerably. The addition of carbonate corresponding to 2 and 4% lime, had a marked effect on the linear contraction. The curve representing the lower firing temperature showed a very appreciable expansion for the larger proportion of lime. As has been stated, "negative" contraction refers to expansion. At temperatures of 1800°F and 1900°F for this clay, the contraction curves demonstrated that for the time factor of the run, vitrification was by no means complete, considering the entire mixture. At 1950°F and 2000°F the raw clay exhibited a great deal of contraction, indicating considerable vitrification. This contraction remained more or less constant for the

two higher temperatures with a lime content of from 2 to 10%, the 2000°F run showing slightly greater contraction. From 10 to 12% lime, and especially the larger proportions, the briquets showed expansion. This indicated that all the carbon dioxide from the carbonate had been expelled but little vitrification had taken place. The slight contraction due to vitrification of a portion of the lime and clay was masked by the relatively great expansion due to the loss of carbon dioxide from the remainder, or what might be termed the excess calcium carbonate. As a result of this action there was no difference in the apparent amount of vitrification at the different temperatures.

Table V gives the data obtained for the crushing strength of the various briquets and Fig. 6 carries the curves plotted from these data. The addition of calcium carbonate lowered the crushing strength of the fired product to a slight extent for the lower burning temperatures and to a much greater extent for the high temperature run. At 2000°F it will be noted that a 2% proportion of lime caused a decrease of approximately 8000 pounds per square inch. The crushing strength of 12,700 pounds shown by the raw clay fired at 2000°F was comparable to that noted in trade specifications for a vitrified brick. In Fig. 6 the effect of 50° increase in temperature, above 1950°F, is strikingly shown. At this higher temperature vitrification was practically complete in the raw clay, had increased rapidly in the specimens low in lime content, and had scarcely begun in those of high lime content. It is quite possible that had the temperature been carried higher than 2000°F, the mixtures low in lime might have shown the same or possibly greater crushing strength than the raw clay.

The porosity curves shown in Fig. 9 indicated an approximately uniform rate of porosity increase with an increase in lime content for all four temperature runs. At 1800°F the porosity for the 20% lime mixture was higher than for the other three temperatures. This indicated that at the higher temperatures some vitrification had taken place and some of the pore spaces had been filled or sealed over by some of the fused material. At 1800°F but little vitrification had taken place and there remained a large amount of pore space. The properties which make for porosity before, during, and after firing, are assets. The evolution of chemically held water, not driven off during drying, is facilitated. The oxidation and volatilization of organic matter is aided. A brick which is porous during firing is less liable to warp than one lacking in porosity. Obviously, pore space should not be understood to refer to large holes in the brick mass. Porosity does cause a brick to absorb water. Excessive amounts of pore space will reduce the mechanical strength and weather-resisting properties of a brick. The porosity of an ordinary paving brick, partially vitrified, may be

as high as 35% and bricks having the appearance of complete vitrification may have as much as 20% porosity. It will be noted that the specimen showing a crushing strength of over 12,000 pounds had a porosity of 23%.

Up to the present nothing has been mentioned in regard to the colors of the samples tested. Obviously color in a brick is of importance, particularly today. Builders are demanding and securing not only brick of good quality but brick of attractive appearance. When fired at 1800°F the raw clay and the mixtures up to 10% lime were red, ranging from a medium to a very light red as the lime content increased. The 12% mixture showed a pronounced medium buff shade of very attractive appearance. When fired at 1900°F and 1950°F the mixtures below 10% lime showed colors of a trifle darker red than when fired at 1800°F. The 10% mixture was of a medium buff color at the higher temperatures as compared with a light red at 1800°F. Briquets fired at 2000°F were all of a buff color for mixtures above 10% lime. The 2 and 4% mixtures showed a dark red color after firing at 2000°F. The change in color produced by lime, most noticeable by the contrast of the 4 and 10% mixtures, was probably caused by reactions between the various acid and basic constituents, resulting in the formation of light colored substances. Further study of the matter of color would be very interesting. Most of the clays in the vicinity of Lincoln, Nebraska, carry relatively large amounts of iron and the production of anything but red brick involves considerable time and expense in the manufacturing operations. It is interesting to note that at present no buff brick are being manufactured in Nebraska, such brick being shipped in from various out-of-state plants.

Conclusions

From the data obtained to date, it is evident that a very considerable amount of work must be done before definite information on clays is available. Sufficient data has been acquired to indicate that it may be possible to very materially improve the qualities of brick now being produced from the so-called ordinary clays. It is evident that lime may be added to some clays to lower the fusing points without destroying valuable properties. The finely powdered calcium carbonate produced no blisters or tubercles. In commercial practice, fine grinding is a factor to be considered in assembling cost data. The addition of lime decreased the drying shrinkage and lowered the burning contraction at all temperatures. It lowered the crushing strength for mixtures fired at high temperatures. At lower temperatures the decrease was not so marked and a brick of sufficiently great strength for all ordinary building purposes was produced. Lime increased the porosity of the

brick up to the point of complete vitrification. The porosity was roughly proportional to the amount of lime and generally inversely proportional to the temperature of firing. The color of the brick was markedly changed by the addition of lime, when proper temperature control was maintained. A study of the chemistry of the compounds in clay, of the reactions during firing and of the compounds in the fired brick will be of great value in further studies of clays.

Acknowledgment The author wishes to express his most sincere thanks and appreciation to Prof. Frankforter who suggested this problem and without whose assistance, completion of the work would have been impossible.

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The very numerous references noted in the Illinois and Ohio *Bulletins*, in Mellor and elsewhere, including the *Chemical Abstracts* were consulted whenever possible. A number of references to the *Journal of the American Ceramic Society* were not read as complete files of this *Journal* were not available.

CERAMIC ABSTRACTS

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Vol. 7 | January, 1928 | No. 1

Author Index to Ceramic Abstracts for January

Author	Page
Agde, G. and Krause, H. F.	14
Agde, G., Krause, H. F., and Lehmann, W. M.	14
Andrade, E. N. daC.	50
Andreasen, A. H. M.	41
Ashley, G. H.	59
Azbe, V. J.	11
Bailey, C. F.	40
Barringer, L. E.	52
Barton Foreign Patents, Ltd.	47
Bartsch, O.	33
Bates, F. and Phelps, F. P.	40
Bates, P. H.	7
Becker, K.	54
Beckmann, H.	55
Bergen, G. B., Sr.	12
Berl, E. and Löblein, F.	11
Biehl, C.	12
Biehl, K.	32
Bicheroux, M.	26
Bisch, M.	48
Bock, W. E.	22
Bock, E. S.	22
Booze, M. C.	35
Borton, E. J.	20, 39
Bragg, W.	49
Bragg, W., Freundlich, H., Gray, R. W., Usher, F. L., and Ewles, J.	50
Brass, W.	33
Brodskii, A. I.	52
Brown, W.	44
Brown, F. E. and Lai, C.-F.	40
Brown, G. G. and Furnas, C. C.	53
Büttner-Werke A.-G., and Kleinmann, F.	37
Chandler, J. E.	49
Chanel, G.	6, 23
Chapman, W. B.	44
Chassevent, L.	7
Clemmer, H. F.	10
Coblentz, W. W.	17
Coliez, G.	30
Comber, N. M.	56
Cope, F. T. and Benzinger, R. F.	47
Correns, C. W.	48
Damour, E.	21
Danielson, R. R. and Sweely, B. T.	13
Dawson, H. M.	50
Demuth, W.	41
Denison, G. W.	42
Diamond, R. W.	51
Dieterich, A.	51
Divine, B. H.	3
Dressler, C.	46
Dunlop, S.	24
Eitel, W.	55
Endell, K.	32
Fahrenwald, A. W.	50
Falconieri	15
Faulkner, J. A.	32
Fitter, H. R.	49
FitzGerald, F. A. J.	46
Florentin, D.	52
Fox, G.	42
Fr.	5
Francis, W.	45
Fritz, H. E. and Clark, J. H., Jr.	41
Gard, J. S. F.	36
Garre, B.	12, 55
Garve, T. W.	28
Gaudin, A. M.	51
Gebr. Siemens and Co.	37
Geller, R. F.	31, 35
Geller, R. F. and Wadleigh, W. H.	56
Gonell, H. W.	12
Granger, A.	51
Groum-Grjimailo, W. E.	45
H. G. H.	5
H. J.	5
Haddan, R.	25
Hanley, W. L., Jr.	43
Hannum, J. E.	59
Hansen, W. E. and Bogue, R. H.	9
Harrison, W. N.	12
Hart, G.	50
Hartford-Empire Co.	24
Hartman, W. H.	42
Hawley, K. A.	40
Haynes, W.	59
Hays, H. J.	24
Heilman, R. H.	36
Heindl, R. A.	30
Helm, G.	58
Heyn, E.	14
Hirsch, H.	36
Hommel, O.	6
Horovitz, K. and Zimmerman, J.	21
Hottinger, A. H.	38
Hughes, R. S.	6
Hume-Rothery, W. and Rowell, S. W.	55
Hurter, H.	21
I. G. Farbenindustrie A.-G.	56
Jacobs, F. B.	2
Jacobsson, R.	37
Jaeger, R.	50
James, W. S.	60

[1] The abbreviation (*C. A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.

Author	Page
John on, B. M. and King, J. A.	31
Jooss, P. F. and Ficheroulle, H. E.	14
K-l	5
Kadow, A.	22
Karsten, A.	22
Kelleher, J.	47
Killefer, D. H.	59
Kingsbury, P. C. and Mehrhof, F. E.	38
Kleinschmidt, R. V.	45
Krak, J. B.	21
Kranz, W.	49
Kühl, H.	8
Kummel, H. B.	48
Laurent, A.	16
Lazarev, P.	52
Lecrenier, A.	21
Lenchner, T.	20
Lewis, E. H.	44
Littleton J. T., Jr. and Dasney, G. A.	20
Lorenz, E. H.	23
Louthan, W. B.	40
Manker, F. W.	14
Marks, A.	37
Marks, E. C.	37
Marlow, J.	47
Martell, P.	5
McAfee, W. K.	57
McBride, R. S.	48
McKinley, T. C.	23
McQuaid, H. S.	56
McSwiney, D. J.	16, 21
McVay, T. N.	11
Meehan, P. A.	46
Menzel, H.	53
Miall, S.	11
Middleton, A. H. and Bride, C.	34, 36
Miller, S. C.	45
Milligan, L. H.	3
Nacken, R. and Grünewald, M. E.	54
Nealey, J. B.	59
Norton Co.	4
O-t	16
Otzen, R.	11
P. M. G.	15
Patent-Treuhand-Ges. f. elektr.	14
Peddle, C. J.	22
Peffer, H. C.	29
Peiler, K. E.	23
Pernet, M.	26
Peters	44
Phelps, S. M.	28
Pipkin, M.	21
Pittsburgh Plate Glass Co.	23
Polk, J. C.	41
Portland-Cementwerk Balingen G.m.b.H.	12
Pratt and Whitney Co.	4
Ransom, G.	27
Rau, J.	23
Reagen, A. B.	3
Reeve, H. T.	37
Rice, W. E.	43, 45
Richter, G. M. A.	5
Roberts, J.	42
Robertson, D.	21
Rodenhauser, W., Schoenawa, J., and von Baur, C. H.	45
Rogers, J. S.	9
Rose, R. E.	53
Ruggles, G. H. and Adams, H. F.	51
Ryschkewitsch, E.	36
Salmang, H.	32, 50
Scheidhauer and Giessing Akt.-Ges.	37
Schoeller, W. R. and Deering, E. C.	49
Schramm, E.	38
Schweitzer, E.	54
Sellar, S. J.	23
Shannon, E. V.	50
Sherman, R. A. and Taylor, E.	35
Sherrington, C., Roaf, H. E., and Edridge-Green, F. W.	6
Spencer, J. F.	49
Springer, L.	21
St.	5, 16
Steinhoff, E.	30, 32
Stewart, L. C.	9
Strutinski, L. B.	50
Stuckey, J. L.	48
Swain, R. E.	17
Tamm, O.	48
Tammann, G. and Rabe, H.	53
Tammann, G. and Tampke, R.	53
Taylor, W. C.	26
Teeple, J. E.	59
Thompson, F. S.	15
Thorpe, E.	56
Thorpe, W. A.	22
Tillberg, E. W.	30
Tillotson, E. W.	20
Totot-Gibaru, C.	14
Trinks, W.	45
Troop, R. S. and Wheeler, F.	26
Tullis, R. L.	35
Turner, W. E. S.	20
Ungerer, E.	53
United States Metals Refining Co.	37
Veimarn, P. P. v. and Hagiwara, T.	53
Verschofen, W.	58
W. H.	15
Wagner, K.	39
Washburn, E. W.	56
Watts, A. S.	39
Webb, A.	29
Wendler, A.	16
Wheeler, E. S., Kuechler, A. H., and Lawrence, H. M.	35
Wheeler, E. S.	36
Wiley, J. W.	58
Wohlenberg, W. J. and Brooks, F. W.	35

Abrasives

Abrasive engineering practice. F. B. Jacobs. *Abrasive Ind.*, **8** [8], 255–58 (1927).—The engineering problems involving grinding are discussed. The standardization of grinding wheels is investigated from standpoint of repetition of process on similar parts. The newest developments in rapid grinding devices for commercial application are discussed. The accuracy now possible by new grinding devices is shown. P.F.C.

How agates are ground in Germany. Anon. *Abrasive Ind.*, **8** [8], 262 (1927).—Huge wheels are mounted near the floor so that the lower portions rotate in pits which are filled with water. Originally sandstone wheels were employed for this wet grinding process, but lately the substitution of silicon-carbide wheels has increased the production remarkably. It is believed (by the German worker) to be impractical, to rest comfortably on a seat before the wheel, so he reclines in a peculiarly-shaped trough, in

front of the wheel and pushes his feet back against a strip nailed to the floor. In this way by tilting his chair forward, it is possible for him to hold the agate in the process of grinding against the rotating grinding wheel. Two men work at the wheel, which has a double bevel face with the high point in the center. This seems to be highly essential in the grinding of very large agates. P.F.C.

Issue abrasive reports. ANON. *Abrasive Ind.*, **8** [8], 269 (1927).—A monograph on abrasives by V. L. Eardley-Wilmot, recently issued, is divided into 4 parts, published separately. (1) Siliceous abrasives, including such materials as quartz and pumice; (2) corundum and diamond; (3) garnet and its uses; (4) artificial abrasives and their manufacture. These papers describe in detail the principal deposits of natural abrasive materials which have been discovered and developed, characteristics and trade requirements of abrasive products, and methods of preparation for the market. P.F.C.

Abrasive engineering progress. ANON. *Abrasive Ind.*, **8** [8], 272–74 (1927).—The newest developments in grinding-wheel design are illustrated and discussed. P.F.C.

Carborundum activities expanded. ANON. *Abrasive Ind.*, **8** [11], 352 (1927).—The Carborundum Co., Niagara Falls, N. Y., has taken over the production of nonmetallic electrical heating elements and resistors, formerly manufactured by the American Resistor Corp. The new company will be known as the Globar Co., and will make silicon carbide in the form of rods and bars, which tend toward the very high conduction of electric currents. It is possible to obtain a glowing heat in this product up to 2600°F. It also is claimed to produce a quick, closely controlled, clean heat in the heating of plate-glass leers, ceramic kilns, enameling furnaces, driers, etc. The work is to be centralized at Niagara Falls. P.F.C.

Prerequisites of successful polishing. B. H. DIVINE. *Abrasive Ind.*, **8** [11], 358–61 (1927).—The prerequisites of successful polishing are taken up from the following points: design of the article to be polished; relation of the preceding processes to that of polishing; absence of vibration; suitable housing for the polishing department; polishing machines; automatic polishing; polishing tools; abrasives; and glue used. It is believed that by a thorough study of the above-mentioned points, the entire problem of polishing, as to tools, equipment, materials, processes, and standardization of polishing will be covered. P.F.C.

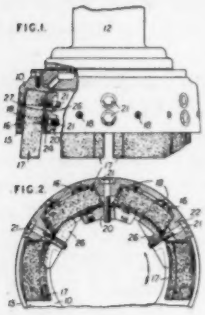
Abrasive engineering progress. ANON. *Abrasive Ind.*, **8** [11], 373–76 (1927).—Some of the newest advances in this division of engineering are illustrated and discussed. The points discussed are: the fitting of a massive face grinding machine with hydraulic drive; design of an air grinder for small wheels; design of surface grinder for production operations; handling of abrasive materials by a screen; improvement of high-speed grinding attachment; and the development of a cylinder hone. P.F.C.

Abrasives and grinding. LOWELL H. MILLIGAN. *Ind. Eng. Chem.*, **19** [10], 1127–31 (1927).—The application of abrasives and grinding wheels to the automotive industry is discussed. Special reference is made to the manufacture of alumina and silicon-carbide abrasives. The use of the right abrasive for different metals is emphasized. The various bonds used in grinding wheels are mentioned and their applications for different purposes are shown. R.J.P.

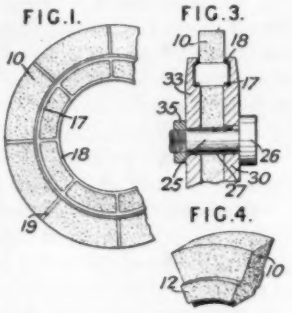
Garnets in the Navajo country. ALBERT B. REAGEN. *Amer. Mineral.*, **12** [11], 414–15 (1927).—The Navajo country occupies northern Arizona and parts of New Mexico and Utah. In this region garnets are found associated with basic intrusive rocks at more than 20 places, occurring most abundantly in agglomerate of volcanic origin, and are sufficiently abundant to be of commercial value in 4 localities, Moses Rock, Mule Ear, Garnet Ridge, near the Utah-Arizona line, and Buell Park in the Red Lake volcanic field. The ultimate source of the garnets appears to be a richly garnetiferous diorite gneiss, boulders of which are fairly abundant as inclusions in the igneous rocks. F.P.H.

PATENTS

Abrading wheels. PRATT AND WHITNEY CO. Brit. 275,545, Sept. 28, 1927. An abrading wheel having segmental abrasive blocks separately mounted consists of a ring secured to a driving spindle and having a flange of slightly conical shape. On the inner face of the flange, bearing members are mounted, two for each abrasive block, by means of screws which allow of adjustment, but not removal, of the members. The blocks are held by two series of plates with screws passing through abutments on the flange. The lower plates have bearing members to engage the blocks, and the plates have projections for that purpose. When the blocks are worn, they are removed and replaced after screwing the plates outward, so that the upper ends of the blocks, when these are replaced, bear against the plates, being held in position by them.



Abrasive wheels. NORTON CO. Brit. 277,013, Oct. 26, 1927. An abrasive wheel is constructed of segments united by a filler, *e.g.*, Babbitt metal, poured while hot into spaces between the segments. A reinforcing structure also may be employed, formed from the metal and having rings on each side of the wheel united to the transverse filling. The segments may have lateral projections against which the rings abut closely, the outer rings being bevelled and forming shoes adapted to be engaged by corresponding faces on clamping-plates which secure the wheel on a shaft. The plate abuts against a collar on the shaft and the plates are held in position by a nut, a bushing being interposed between the abrasive ring and the shaft. Steel wires may be embedded in the rings, and the projections may have indentations to hold the rings; the fillers may be omitted. The metal fillers may extend only to the rings, the spaces outside the rings being filled with a mixture of graphite and sulphur; the filler between operative portions of the segments is such as to wear away at substantially the same rate as the segments.



Art

Chicago enamelers hold colorful meeting. ANON. *Ceram. Ind.*, **9** [5], 578–80 (1927).—Report of a meeting of the Chicago Enameler's Club is given. The chief discussion was on the subject of color and its use as a sale stimulant. Color is recognized as having 3 dimensions: hue, value, and intensity. With this measurement of color has been determined a system of color harmony which tells the amount of a certain color to use with another color of known dimensions. This system of color harmony is just as important as the notes on a musical scale. Colors have a generally accepted meaning and they also affect the human system; *e.g.*, colors with low intensities, such as blues and greens, suggest strength, reserve, calmness, and they depress one physically; they cool or subdue. The reds and oranges excite the emotions, stimulate the body, and cheer; they are symbolic of sunlit foliage and fire. F.P.H.

New instrument to produce color schemes. ANON. *Ceram. Ind.*, **9** [5], 600 (1927).—A new instrument by means of which the decorative artist is enabled to reach his desired object (an ideal color scheme) has been made by Adam Hilger, Ltd. The instrument is called the Multochrome and it operates on the following principle. The various elements of a pattern are photographed separately in such a way that they may be projected in combination under such conditions that each element is entirely under

control in regard to color and brightness. The importance of the Multochrome in the evolution of color schemes may be judged from the following leading features, (1) the design is projected on a screen and may be varied simultaneously by a number of observers, (2) each element of the design may be colored independently, (3) the brightness of each element of the design may be altered independently. These features, together with the simplicity of the controls, enable the operator to make variations in the color composition of a design which would otherwise entail many hours of work on the part of the artist or workman. F.P.H.

On the history of the ceramic industry in Silesia. P. MARTELL. *Keramos*, **6** [8], 297–99 (1927). F.P.H.

The painting of ceramic ware. ANON. *Keramos*, **6** [8], 300–301 (1927).—The methods of applying colors to ceramic ware are discussed. Numerous formulas for various colors are given. F.P.H.

The mirror in interior decoration. FR. *Diamant*, **49** [2], 21–24 (1927).—Modern interior decoration is discussed. The use of mirrors as decorative media in the modern homes or salesrooms, etc., is taken up. Examples of original applications of large mirrors for decorations are listed. E.J.V.

Screens or patterns on windows. H. J. *Diamant*, **49** [2], 28–29 (1927).—A discussion of various types of decorative windows which are made with patterns of different design, coats of arms, emblems, or initials on them. E.J.V.

Glass mosaics. K-1. *Diamant*, **49** [6], 104–106 (1927).—A discussion of the old art of glass mosaic production which was the beginning of Christian glass staining work. The examples of glass mosaics of the ancient days are touched upon. Their use in the production of colorful windows and the effect of the advances in the glass industry on the production thereof are discussed. E.J.V.

Two valuable works on English stained glass. ST. *Diamant*, **49** [6], 112 (1927).—A brief discussion of "English Stained Glass," by Herbert Read, and "English Medieval Painted Glass," by J. D. Le Couteur. E.J.V.

Two Chinese porcelain beakers. H.G.H. *Bull. Met. Mus. Art*, **22** [10], 250 (1927).—During the reign of Wan Li (1573–1619) of the Ming dynasty, the imperial potters became very expert and were particularly noted for their combinations of overglaze enamels with underglaze blue, and this style is known as the "Wan Li five-color style." Owing to the exhaustion of local deposits of fine porcelain clay the potters had to contend with severe technical difficulties and in consequence much of their larger work shows imperfections. Two large imperial vases of the Wan Li date-mark have recently been added to the Museum collection and are on exhibition in the Room of Recent Accessions. These pieces of the so-called beaker shape with flaring mouth and bases, stand nearly 3 feet high. The decoration consists of the imperial pattern of 5-clawed dragons and phoenixes against a background of conventional "fairy" flowers, vines, and flaming jewels, and colors include underglaze blue and overglaze green, red, and yellow together with a brown pigment used chiefly for outlines. The red, blue, and green are all strong colors applied somewhat roughly so that they must be seen from a slight distance to give the most harmonious effect. These vases are typical of the Wan Li period and are of great interest to the student. The ruggedness of the form and the contrasting brilliance of the colors tend to cover any slight technical defects by discouraging too close an examination, a result which seems to have been intended by the designers. A.A.A.

Pottery from Zygouries. GISELA M. A. RICHTER. *Bull. Met. Mus. Art*, **22** [10], 251–52 (1927).—Recent excavations help to give us a picture of prehistoric Greece. From one of these, at Zygouries, near Corinth, the Museum has received the pottery exhibited this month in the Room of Recent Accessions. It is the gift of the Greek Government, through the good offices of the American School of Classical Studies in Athens. The site was excavated in 1921–1922 by the American School under the

direction of Carl W. Blegen and with the financial aid of Mr. and Mrs. Edward Robinson and Richard B. Seager. Though evidently a modest community, without splendor and importance of Tiryns and Mycenae, it had a long and continuous existence, especially flourishing in the Early Helladic III (about 2200–2000 B.C.) and Late Helladic III (about 1400–1150 B.C.) periods. Six of the 17 vases belong to the early epoch. They are bowls, jars, and a jug of sturdy proportions. The rest are wheel-made goblets, ladles, jars, jugs, and a large stirrup vase of the Late Helladic III period. They were all found in a large building filled with hundreds of vases set close together. Though some of them had been cracked and shattered by the fire which had evidently destroyed the building, the rest had a fresh new appearance as if they had never been used. The supposition is that the building was a potter's shop with wares stacked for sale.

A.A.A.

Color vision. CHARLES SHERRINGTON, H. E. ROAF, AND F. W. EDRIDGE-GREEN. *Engineering*, **124,** 542 (1927).—The report of the British Associations Committee on color vision and on classification of color blindness distinguishes between color blindness and color confusion. Yellow-green confusion, for example, indicates inability to discriminate between these 2 colors, but not decreased sensitivity to their wave-lengths.

H.H.S.

Thirty centuries of Chinese applied art. ANON. *The Graphic*, **118,** 158–59 (1927).—Reproductions in color of an owl of the Chou dynasty (B.C. 1122–255), a lion of the T'ang dynasty (A.D. 618–906), and a figure of Shou Lao, god of longevity, of the Ming period (A.D. 1500). The 1st is from the Eumorfopoulos, the 2nd from the Oppenheim, and the 3rd from the Rothschild collections. H.H.S.

The Chinese god of war in Ming pottery. ANON. *Illust. London News*, **171,** 714 (1927).—A reproduction in color of a statuette of Kuan Yü from the Eumorfopoulos collection. Buff stone ware with violet-blue, turquoise, and yellow glazes. Dates from 1500, and stands over 20 in. high. The blue is derived from cobaltiferous ore of manganese. H.H.S.

Ceramolatry. ANON. *Times Literary Supp.*, Oct. 27, 1927.—Reviewing J. Baikie's Book "The Glamour of Excavation," the author registers a protest against the 2 "obsessions" of modern archaeologists: (1) that everything found must be kept, to the infinite encumbrance of museums and the swelling of cost maintenance and publication; (2) the idea that pottery in particular has value and interest, and is communicative beyond even the deliberate utterance of antiquity. H.H.S.

PATENTS

Decorating glass. O. HOMMEL. U. S. 1,642,441, Sept. 13, 1927. Heat stored in glass during manufacture is utilized for fusing to the glass a granular powder made of stable glass.

Decorated glass ware and process. ROBERT S. HUGHES. U. S. 1,647,362, Nov. 1, 1927. As a new article of manufacture, transparent glass plate, etc., having on the undersurface a design of metallic color, and a backing for the design of vitreous enamel, the design and the enamel being fused together and to the body behind the display surface, so that the design is viewed through a transparent surfacing to receive a lustrous or polished effect.

Glass manufacture. G. CHANEL. Brit. 275,142, Sept. 21, 1927. Artificial flowers are made from low-expansion glass, such as that known by the registered trade mark, Pyrex, by blowing and drawing out small cylinders of the glass and pressing and bending the cylinders to form petals and leaves, welding the petals and leaves on to a stem by means of a blowpipe flame, and then annealing the welded spots by means of a gas jet without unduly heating the adjacent parts. The production of a branch of lilac is described.

Cement, Lime, and Plaster

New investigation of gypsum plasters. L. CHASSEVENT. *Chim. Ann.*, **7**, 43–68 (1927); *Rock Prod.*, **30** [21], 89 (1927).—C. describes a calorimetric method for the analysis of plasters by which the course of the heating of the plaster may be followed, and a knowledge of its properties rapidly obtained. Anhydrous calcium sulphate, dehydrated below 300°, is rehydrated practically instantaneously, and a measurement of the heat evolved in gram-calories during the first 2–3 min. (X) is due to this cause, so that the weight in g. (p) of hydrous calcium sulphate in the sample is given by the expression $p = (X-20)/20$, the heat of dissolution of the hemihydrate being 20 g.-cal. Calcium sulphate dehydrated between 300 and 600° requires 7 days for complete rehydration, and the period necessary for any particular sample may be determined either, (1) by measuring the electrical resistance which, when the plaster contains no calcium sulphate dehydrated above 300° does not increase after several hours, or (2) by a determination of the increase in weight of a known weight of the powder kept under water and dried at 50 to 60° after periods of 2, 7, and 15 days; all increase in weight between 2 and 7 days corresponds with the hydration of calcium sulphate which has been heated between 300 and 600°C and may increase after 7 days with that heated above 600°, 1 g. of anhydrous calcium sulphate requiring 0.26 g. of water for hydration. By this method the influence of the method of heating on various samples has been investigated. The lack of hardness in set plaster may be due either to the presence of overburnt particles which rehydrate slowly, or to the addition of too much water, the best proportion being 45–60 g. per 100 g. of plaster. By mixing plaster with only slightly more than the theoretical quantity of water required for hydration at 80–90° and subjecting the mass to pressure (varying with the conditions and the size of the particles employed), samples having an apparent density greater than 2, a high resistance to compression and an appearance like marble have been obtained. An attempt thus to prepare artificial alabaster was unsuccessful, the samples always being opaque and having a density less than 2.3. If plaster is hydrated with boiling water, care being taken that the temperature of the mass never falls below 63° and the liquid mass is stored in steam-jacketed vessels, it remains plastic for many hours, but on allowing the temperature to fall to 40° it sets in the usual manner. By this means a smaller quantity of water is required for hydration, the plaster may be stored during use, and machinery employed to mix and work it. F.P.H.

Effect of sulphates on mortars made with different cements. ANON. *Le Ciment*, **343**, 334 (1927); *Rock Prod.*, **30** [22], 103 (1927).—Tests were made of 1:3 plastic mortar specimens, 10x2 cm., using fused cement, Holderbank, Portland, and slag cement. Five per cent by weight of sand, sulphates of potassium, calcium, magnesium, sodium, and ferrous and ferric sulphates were used, cured in moist air, and observed at ages of 6 months and one year. Potassium, calcium, and magnesium sulphates had the most detrimental effect which varied as their SO_3 content (46 and 32.6% respectively). Although ferric sulphate has an SO_3 content of 43%, it appears inactive, permitting the conclusion that the nature of the base has some effect. In practice, only the slag and Portland cements are attacked by these sulphates; Holderbank and fused cements remain intact. The resistance to sulphates seems to be a function of initial strength, rather than of the chemical composition of the cement. F.P.H.

British research on lime and lime mortars. ANON. *Rock Prod.*, **30** [21], 53–58 (1927).—A summary of existing information preparatory to an extensive research program is given. Tentative standard specifications are given for quicklime, hydrated lime, and hydraulic lime. F.P.H.

Present status of Portland cement and possibilities of supercements. P. H. BATES. *Rock Prod.*, **30** [22], 77–80 (1927).—There are too little data to show that tensile or

compressive strength is the criterion upon which all the needed properties of cement depend. Resistance to weathering, or to the action of salt solution, constancy of volume under alternate wetting and drying, low coefficient of thermal dilation, minimum volume change during setting and hardening, and tensile and transverse strength of concrete are important. It is not generally agreed as to what constituents or compounds in cement give tensile strength. There is no agreement as to what are the constituents in Portland cement or how they react with water. But the situation is not quite so chaotic as it appears. In examining cement clinker all note the same constituents but name them differently. B. also discusses (1) high-lime Portland cement; (2) effect of increasing the lime content; (3) effects of magnesia; (4) quick-hardening cements other than Portland cement; (5) barium compounds having hydraulic properties; (6) relation between strength and durability; (7) need for study of catalyzers or accelerators for Portland cement. F.P.H.

Clinker cement. HANS KÜHL. *Zement*, **37**, 869–71 (1927); *Rock Prod.*, **30** [22], 103 (1927).—The German periodicals *Zement* and *Tonindustrie-Zeitung* have issued special numbers devoted to the celebration of the 50th anniversary of the German Association of Portland Cement Manufacturers. Both contain articles on the present status of clinker research. While Janecke (*Tonindustrie-Zeitung*) maintains the existence of the Janeckeite, discovered by him and identical with Tornebohm's alite, whose formula he gives as $8\ CaO \cdot 2 \cdot SiO_2Al_2O_3$, Dyckerhoff (*Zement*) attributes the hydraulic properties of cement to calcium silicates, stating that tricalcium aluminate does not exist in Portland cement clinker and that alumina occurs in ternary compounds of lime-silica-alumina, making up the minor constituents of the clinker. Heyn and Wetzel in Germany and Rankin and Wright in the United States oppose Janecke's theory. In 1914 K. proved that samples of the composition of Janeckeite possess properties different from those of a good Portland cement and cannot be the main constituent of cement, identical with alite, for this reason. Janecke's formula contradicts the evidence of low-alumina cements with 4–5% alumina, which are known to have the highest content of alite. On the other hand, Dyckerhoff's claim that bicalcium silicate is alite seems unjustified, as K. knows that even large lumps of clinker deteriorate due to bicalcium silicate. Dyckerhoff's proposition that alite be designated as bicalcium silicate and belite as tricalcium silicate seems unfounded at this date. K. is inclined to believe that alite is a solid solution of a highly basic calcium silicate and a highly basic calcium aluminate with possible lime in solution. This statement was first made by him in 1914. For previous data on these theories see *Ceram. Abs.*, **6** [5], 167 (1927); *ibid.*, **6** [6], 239 (1927). F.P.H

Determination of sulphates in Portland cement. ANON. *Zement*, **33**, 701–702 (1927); *Rock Prod.*, **30** [22], 102 (1927).— The German specifications for cement now in force require magnesia content not greater than 5% and sulphuric anhydride content not greater than 2½% in ignited Portland cement. This specification is not exact, as it has frequently been interpreted to mean that a previously ignited sample is to be tested for magnesia and sulphuric anhydride content. While the magnesia content shows no effect of previous ignition, the sulphuric anhydride content decreases considerably, depending upon the duration and intensity of ignition. Ignition results in the formation of sulphur trioxide from gypsum and the sulphur trioxide is further decomposed into sulphur dioxide and oxygen. The content of these reactions is determined by the temperature and laws of chemical equilibrium. The presence of sulphides in cement renders these reactions even more complicated, as the oxidation of the latter requires oxygen, thus upsetting the chemical equilibrium. Tests were made at the laboratory in Karlsruhe following standard procedure using 3 different cements. F.P.H.

Change of time of set of Portland cement. ANON. *Zement*, **46**, 845 (1927); *Rock Prod.*, **30** [22], 103 (1927).—A standard Portland cement may become quick setting when exposed to the action of the sun for some time, even when packed in barrels or bags, indicating that insufficient gypsum was added. Alkalis may also cause quick setting. High alumina cements are characterized by quick set and may develop a change in their setting properties, particularly with a high content of alkalis. Quick setting may be counteracted by increasing silica and, particularly, iron oxide. As the silica content is limited for various reasons, iron oxide appears the logical constituent to be used as a means of combating the occurrence of changes of time of set of Portland cement. F.P.H.

Plastic magnesia cements. LEROY C. STEWART. *Ind. Eng. Chem.*, **19** [10], 1139–43 (1927).—A discussion of the raw materials, chemical and physical tests and applications of magnesium oxychloride cements. It is pointed out that while a chemical test is all that is required for the magnesium chloride, physical tests are necessary to determine the suitability of the magnesia. Some of the physical tests are (1) determination of strength, (2) time of set, and (3) volume change. Tables showing typical examples of these properties are included. Applications of this cement are in stucco, composition flooring, wall plaster, fire-resistant paint, etc. R.J.P.

Composition of commercial chemical limes. J. S. ROGERS. *Ind. Eng. Chem.*, **19** [10], 1157–58 (1927).—A report of data obtained while preparing specifications for chemical lime. A table of analyses of 16 hydrated limes and 19 quicklimes is given. The constituents determined were SiO_2, Fe_2O_3, Al_2O_3, P_2O_5, Mn_2O_4, CaO, MgO, SO_3, CO_2, loss on ignition, and insoluble matter in 1:9 HCl. R.J.P.

The combination of lime in Portland cement compounds (preliminary investigation). W. C. HANSEN AND R. H. BOGUE. *Ind. Eng. Chem.*, **19** [11], 1260–64 (1927).—A preliminary study of the influence of small amounts of magnesia, ferric oxide, alkalis, and other minor components on the combination of lime in Portland cement of various compositions at various temperatures. The furnace used in this study was a continuously operating electrical resistance furnace obtaining temperatures up to 1550°C. Care is taken to obtain constant conditions and freedom from contamination. Only one base composition was used in this preliminary study, the composition being 67% CaO, 10% Al_2O_3, 23% SiO_2. Substitutions of magnesia and the alkalis were made for lime, and ferric oxide was substituted for alumina. The results obtained with this base composition indicate (1) that small amounts of soda or potash produce very little increase in the combination of lime with silica and alumina; (2) that replacement of alumina by small amounts of ferric oxide, or the replacement of lime by small amounts of magnesia aids materially in promoting the combination of lime, the influence of magnesia being greater than that of ferric oxide, and (3) that magnesia and ferric oxide together are much more effective than replacement by either one. R.J.P.

A new supercement. ANON. *Eng. News Rec.*, **99** [11], 448 (1927).—The Vulcanite Portland Cement Co., announces the manufacture of a new "supercement," the name given to a product discovered in 1914 by G. F. Goddard. It is made from normal Portland cement clinker by nearly the same process as that employed in the manufacture of Portland cement. It contains no waterproofing compounds. It differs from the usual Portland cement in that part of the gypsum used in regulating the "set" is replaced with a special plaster treated with a small per cent of oak-gall tannin. This treated plaster after being formed in slabs and dried in rotary kilns is called "Catacoll" and is added to Portland cement clinker, along with the remaining gypsum, so that the total SO_3 content is below the specified maximum. It is claimed that the tannin influences the constituents of the clinker to form a hydrate of much greater colloidal nature than that of Portland cement. This supercement meets all requirements and standard

specifications and has the claimed added advantage of becoming stronger at later periods. The main claim is that it is very much more workable and produces a greater density and also possesses oilproofing and waterproofing qualities. It will be marketed in multi-wall paper bags at $.75 more per barrel than normal Portland cement.

P.F.C.

Dissolution of German cement cartel announced. ANON. *Eng. News Rec.*, **99** [12], 488 (1927).—The west German cement cartel announces its dissolution, effective December 31, 1927, by the approval of 75% of the major stock holders, according to advices to the U. S. Dept. of Commerce. This is one of the 4 cement cartels of Germany. Three cover west Germany, north Germany, and south Germany respectively, and the other (the so-called Smelter Cement Cartel) is associated with the Ruhr iron and steel industry. The local cement market will be affected by this dissolution of the west German cartel. The decision of this termination lay with the largest cement works in Germany; namely, the Wickingsche Portland-Zement-Wasserkalkwerk of Muenster. The reason given is that a newly-developed and cheaper process of production has been found and hence it wishes to be freed from conventional price ties. It is estimated that this concern carried 42% of the entire west German cartel production quota. P.F.C.

Developing of sound-absorbing plasters. ANON. *Eng. News Rec.*, **99** [14], 542 (1927).—The Bureau of Standards at Washington is working on the development of a sound-absorbing plaster for use in auditoriums, etc., in order to prevent excessive reverberation, as often found in such rooms, due to the high reflecting power of the usual plaster. They believe that it will be necessary to produce a plaster, in order to fulfill this condition, that will have a surface absorption of 10–15% of the incident sound. Pumice plasters (plasters with porous aggregate) are found on the market now, but present many difficulties in application and require extremely careful workmanship. It has been found that by adding small amounts of alum and lime carbonate to the calcined gypsum and sand, a very absorbent or market surface porosity is obtained in the plaster. This porosity of surface is obtained when the plaster is wet, the alum and the carbonate forming carbon dioxide, with the production of very small gas bubbles in the plaster. The addition of many and very fine aggregates has been tried; but with varied and questionable success. The best results were obtained when pumice, calcined diatomaceous earth, and tufa were employed. P.F.C.

Load-bearing tile for light occupancy construction. ANON. *Eng. News Rec.*, **99** [17], 692 (1927).—The U. S. Gypsum Co., announces the manufacture of a new product, namely "Structolite," which is a load-bearing, incombustible tile. It is especially adaptable to bearing partitions in light buildings and for the erection of exterior walls. The tile are made from structolite cement, possess hollow cores, and will withstand 1000 lbs. per sq. in. of gross area. They come in standard 16-inch sizes of 4 sections: 8x8, 8x6, 8x12, and 6x12. The maximum weight for any tile block is 35 lbs. The manufacturers claim the following for their new product: (1) the tile may be sawed, nailed, and fitted with the ease of soft wood; (2) brick veneering is easily laid up over the tile; (3) a true surface is provided for exterior stucco; and (4) tile lintels may be made from them, quite readily, by merely reinforcing the tile. P.F.C.

Canadian cement production increase. ANON. *Can. Engineer*, **53**, 32 (1927).—A new high record for the industry in Canada is indicated by the finally revised Government Statistics for 1926. Shipment amounted to 8,707,021 barrels, valued at $13,013,283. The 7 firms operating report a total capital investment of $41,380,000.

H.H.S.

Use of calcium chloride for highways. H. F. CLEMMER. *Can. Engineer*, **53**, 495–97 (1927).—The cost of $CaCl_2$ treatment is $300 per mile of road per annum. Its

use is justified by conservation of surface material, the loss of which would amount to $600 per mile and in addition there is elimination of dust nuisance. In the curing of concrete for pavement, $CaCl_2$ has superseded the old method of covering the pavement with dirt or straw to keep it wet. The amount of $CaCl_2$ needed differs with different cements, but 2% (by weight) of the cement is always sufficient. In order to secure maximum acceleration the amount may be 4%. H.H.S.

Better concrete (water-cement ratio). S. MIALL. *Chem. and Ind.*, **46,** 975–76 (1927).—Rapid hardening concretes and concretes possessing special characteristics such as resistance to alkali attack, can be made with the aid of the newer aluminous cements or of special Portland cements, but common Portland cement, which is much more generally used than the others, may be made to give better concretes than were obtained a few years back or it may give equally good concrete at a lower cost. The amount of water used per unit weight of cement is the main factor, and it is said that the addition of each pint of water above the proper amount has the same effect on concrete as leaving out a quart of cement. The proper ratio to obtain a concrete strength of 3000 lbs. per sq. in. in 28 days is 5.5–6.0 gals. of water to the bag of cement, but as the sand and gravel aggregates usually contain some water this may require a deduction of 1.6 gals. H.H.S.

Operation of lime and cement kilns. VICTOR J. AZBE. *Fuels and Fur.*, **5** [10], 1389–90 (1927).—Importance of relative temperatures of heat-radiating and heat-absorbing media. Effects on efficiency of low CO_2 and excess air. Steam for blowing. A.E.R.W.

Hard-finish gypsum plasters. T. N. MCVAY. Univ. Ill. Eng. Expt. Sta., *Bull.*, No. 163, 5–43 (1927).—Plasters of widely varying physical properties can be produced by treating gypsum with soluble sulphates before or after the final calcination; the former method causes the plasters to be more plastic but at the same time to have higher shrinkage. Potash alum, on the whole, seems to produce more satisfactory results than Glauber's salt, but it is quite probable that other soluble salts may be as efficient as these. The physical properties of the plaster can also be controlled to a considerable degree by the temperature of calcination, assuming that the concentration of the soluble sulphates remains fixed. The higher the temperature of calcination (within the range from 450° to 750°) the slower are the reactions that take place in setting. The greater strength of the plasters calcined at high temperatures, as compared with those calcined at low temperatures is probably due to the more thorough crystallization of the former and also the smaller amount of mixing water used, this producing plasters of greater hardness and density. (*C. A.*)

Supercements. R. OTZEN. *Zement*, **15,** 639–42, 670–73, 691–96, 719–23, 737–41, 762–63, 778–83 (1926).—The properties distinguishing German supercements from normal Portland cements are higher tensile and compression strengths, especially at early ages, more rapid set and hardening, greater fineness, more uniform chemical composition, and better burning. A review of the literature dealing with supercements, especially in comparison with normal Portland and aluminous cements, is given. (*C. A.*)

Aluminous fused cements. E. BERL AND F. LÖBLEIN. *Zement*, **15,** 642–43, 673–77, 696–99, 741–45, 759–62, 783–85 (1926).—The study of the system CaO–Al_2O_3–SiO_2, using pure substances, shows the fields of aluminous fused cements to be (1) a strip extending from the Portland cement field to a compound of 80% Al_2O_3 and 0% SiO_2 and inclosing all the compounds having hydraulic properties; (2) an irregular field within this strip including those compounds exhibiting especially high cementing values. A sharp line cannot be drawn between the compounds of Portland and Al_2O_3 cements. Slow cooling of the melts improves the hydraulic properties. The sintering and melting

points lie close together. The resistance of Al_2O_3 cements to 6-month storage in 12% $MgSO_4$, 15% NaCl, and 10% $KHSO_4$ solutions increases with the Al_2O_3 content. Bauxites low in SiO_2 are suitable for the manufacture of Al_2O_3 cements. Bauxites high in SiO_2 produce cements belonging to the border-land of Portland and Al_2O_3 cements. The Fe_2O_3 in bauxites can easily be reduced by C and CO in the process. Tempering solutions of $CaCl_2$ and Na_2SiO_3 do not greatly benefit Al_2O_3 cements while solutions of sulphite waste and sugar completely destroy them. The dominant crystal phase of fused cements is $CaO \cdot Al_2O_3$. An exothermic reaction, amounting to as much as 100°, was observed during the hydration of $3CaO \cdot Al_2O_3$. (*C. A.*)

The cause of setting disturbances of aluminous cements. H. W. GONELL. *Zement*, **15**, 714–15 (1926).—Aluminous cement pats have friable, crumbling edges when the set occurs in a CO_2-rich atmosphere. As much as 4.6% CO_2 is absorbed by the friable portion compared with 1.6% in the sound part. (*C. A.*)

Burning of cement. BERNWARD GARRE. *Zement*, **15**, 844–47 (1926).—Strong exothermic reactions are observed during the heating of technical BaO and SrO with SiO_2 or Al_2O_3 at 350° and 450°, respectively. The electric resistances decrease abruptly at these points. BaO freshly prepared from $BaCO_3$ does not show a similar drop below 500°. CaO reacts with Al_2O_3 at about 600°. A mixture of 66% CaO, 11% Al_2O_3, and 23% SiO_2 whose components had been ignited at 1000–1100° combined to form a hard mass within 2 hrs. Without ignition these compounds did not react. Conductivity measurements indicate that around 600° some slight reaction occurred without the presence of a liquid phase. (*C. A.*).

Aluminous fused cement, its preparation, properties, and application in construction. C. BIEHL. *Zement*, **16**, 115–23, 139–46 (1927).—A general description is given of the manufacture of fused aluminous cements. The distinguishing properties such as early high strength, resistance to acids and salt solutions, high heat of hydration, and resistance to low temperatures during hardening, adapt these cements to many special purposes in construction. (*C. A.*)

PATENTS

Molded articles from magnesium oxychloride or similar compositions. G. B. BERGEN, SR. U. S. 1,638,821, Aug. 16, 1927. A fluid mixture is formed from a calcined and powdered metallic oxide and a metallic chloride solution, *e.g.*, from MgO and $MgCl_2$ solution, and after initial setting the material is divided into portions and a pigment and additional chloride solution are added to each portion, fluidity being maintained; after further setting the different portions are commingled, allowed to stand for still further setting, and, before hardening occurs, the mass is kneaded and worked to intermingle the colors and remove the air or gas cavities, and molded. (*C. A.*)

Process of manufacturing acid-proof hydraulic binding agents. PORTLAND-CEMENTWERK BALINGEN G.M.B.H. Brit. 269,549, April 12, 1927. Barium sulphate or witherite, mixed with sand, clay, or other materials rich in silicic acid, is burnt to the sintering or fusing point, preferably with an admixture of coal or coke. The process is arranged so that the percentage of barium aluminate is kept low, and a proportion of aluminium silicate or iron oxide is formed. The ground product is highly resistant to acids, sulphates, etc.; the resistance is increased by treatment with a sulphate solution. (*B. C. A.*)

Enamels

Vitreous enamel slips and their control. W. N. HARRISON. *Jour. Amer. Ceram. Soc.*, **10** [12], 970–94 (1927).—The purpose of this work was to study vitreous enamel slips in order to develop adequate means for measuring and controlling their consistency

under plant conditions. A suitable laboratory means for determining their consistency was first selected, and the effect of various factors upon consistency determined by this means. In order to learn something of the mechanism by which changes in consistency take place, observations were made upon the physico-chemical nature of the different phases of several typical slips; also, the state of flocculation of the finer particles of suspended matter was observed under different conditions known to produce slips of different consistencies. A simplified method of determining consistency, suitable for plant use, was then devised, and the work carried into the field. This simplified means was put into use in conjunction with other tests, in order to obtain data for correlating consistency as determined by this method with the working properties of the slips.

Routing ware through the enameling plant with least complications. ANON. *Ceram. Ind.*, **9** [5], 558–60 (1927).—The enameling department of the Alaska Refrigerator Co. has a routing system with card-record that has proven practical and least troublesome. Some other features of the plant are: (1) rollers taking incoming sheets to storage pile; (2) portable rack used for short firing storage; (3) novel method for hoisting boxes to conveyer. F.P.H.

To make study on construction of refrigerators. ANON. *Ceram. Ind.*, **9** [5], 560 (1927).—The American Engineering Standards Committee, upon request of the American Home Economics Assn., is to call a representative conference to consider the desirability of establishing specifications and standards for household refrigerators which will assure their being well constructed and efficient, and establishing, if necessary, a number of carefully defined grades so that the buyer may be certain of good performance. F.P.H.

How the British enameler makes his ware. ANON. *Ceram. Ind.*, **9** [5], 561–62 (1927).—An article tracing the progress of the British enameling industry. The one-gray coat ware popular in America has no market in England, white ware being alone salable for domestic purposes. The American "all-white kitchen" causes enamelers to turn to the possibility of enameled table tops, refrigerators, etc., while enameled stove parts have been universally adopted. The British enameler uses less lime and fluorine than do Americans. Crazing is rare while fishscaling is largely unknown. Sodium antimonate is seldom used, and antimony in any form is not employed in large quantities. Barium compounds are used more widely in America than in England. Lead, of course, is employed only for cast-iron enameling, and then only in minimum quantities. Wet process for cast iron has made little progress in Great Britain. Generally speaking, higher melting enamels are employed in England and nearly all furnaces are coal fired, and this method has been revolutionized in recent years by the introduction of recuperators and regenerators for saving fuel. F.P.H.

The relations between the composition and properties of enamel for steel plate. R. R. DANIELSON AND B. T. SWEELY. *Sprechsaal*, **59**, 80–81; *Chem. Zentr.*, **1**, 2236 (1926).—Fourteen base and white-surface enamels were applied on plates and their resistance to shock, temperature changes, and AcOH tested. Coefficients of expansion and resistances to compression were first determined. Replacement of B_2O_3 by Na_2O increased the coefficient of expansion, the latter also being dependent upon the time of fusion and upon other influences. By replacing B_2O_3 step by step by Na_2O, the resistance to compression of base enamels diminished, that of surface enamels increased. Impact tests without bending are suitable for testing the adhesion of the enamel. The surface layer must be as thick as the base layer. Shock requirements for curved enamel parts serve as an indication of the toughness of the enamel. The resistance to temperature changes is increased when the coefficient of expansion of the base enamel is the same as, or greater than, that of the surface enamel. The resistance of the surface enamel to AcOH decreases directly with replacement of B_2O_3 by Na_2O. (*C. A.*)

Behavior of fluorides in glasses and enamels. II. G. AGDE, H. F. KRAUSE, AND W. M. LEHMANN. *Z. angew. Chem.*, **40**, 804–808 (1927).—Seven members of a series of fluoride-opal glasses, previously microscopically examined (See *Ceram. Abs.*, **6** [9], 374 (1927)) were subjected to X-ray analysis. In the cases in which sodium fluoride or aluminium fluoride had been used as opalizer, the precipitate was found to be sodium fluoride, while a glass opalized by calcium fluoride contained a precipitate of calcium and sodium fluorides in varying proportions. The results confirmed the microscopical tests. (*B. C. A.*)

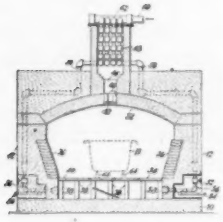
The effect of fluoride additions to glasses and enamels. III. The causes of fluorine losses during the melting of glasses and enamels with fluoride additions. G. AGDE AND H. F. KRAUSE. *Z. angew. Chem.* **40**, 886–95 (1927).—A microscopic and Röntgen ray study of fluorine-containing silicates showed that the opacity is caused by the separation of a crystalline material in the ground mass, and not by the separation of gas bubbles. With additions of NaF and AlF_3 opacity is caused by the crystallization of NaF; with CaF_2 additions CaF_2 and NaF separate jointly, the ratio depending on the composition and the thermal treatment of the silicates. The loss of F occurs through the volatilization of the added fluorides, especially NaF and AlF_3, rather than through the formation and volatilization of SiF_4. For Part I see *Ceram. Abs.*, **6** [9], 374 (1927); For Part II see preceding abstract. (*C. A.*)

BOOK

Physical Metallography. E. HEYN. Translated from the German by M. A. Grossmann. 440 pp. New York; John Wiley and Sons, 1927. Price $6.00.

H.H.S.

PATENTS



Enameling furnace and method of preparation. FORREST W. MANKER. U. S. 1,648,001, Nov. 8, 1927. In a furnace for enameling bath tubs, the combination of a heating chamber having its side walls inclined upwardly and outwardly from the floor, the floor having a series of ports extending lengthwise of and adjacent to walls, and means for supplying hot gases to the interior of the chamber through floor ports.

Luminous enamels. P. F. JOOSS AND H. E. FICHEROULLE. French 610,454, May 9, 1925. The metal surface to be enameled is coated with a deoxodizing layer, then with a mixture of lead-free flux and unground phosphorescent zinc sulphide, with or without a small quantity of radio-active substance. The article is then fired rapidly until the flux just melts. The process is applicable to the enameling of glass and ceramic products. (*B. C. A.*)

Enameling sheet iron. C. TOTOT-GIBARU. French 610,645, Feb. 5, 1926. The cleaned sheets are heated at 420° and covered with an enamel containing fluorine, boric acid, zinc oxide, and antimonious oxide in a lead-free flux containing silica, alumina, lime, and alkali. Subsequently a 2nd layer of enamel similar to the 1st is applied, but containing stannic oxide and pigments such as ferric, manganous, or cobalt oxide in place of the antimony oxide of the 1st layer. For sanitary ware a 2nd layer similar to the 1st may be used instead of the colored layer. (*B. C. A.*)

Production of opaque, readily-fusible glass or enamel. PATENT-TREUHAND-GES. F. ELEKTR. Ger. 440,298, Dec. 5, 1924. Insoluble compounds of boron or silicon with other metalloids or with acids, such as boron nitride or phosphate, or the corresponding silicon compounds, are added to the glass flux. (*B. C. A.*)

Glass

Some aspects of American glass tank furnace practice. FRED S. THOMPSON. *Jour. Amer. Ceram. Soc.*, **10** [12], 956–69 (1927).—A summary of information secured in answer to a questionnaire dealing with some of the features of glass tank operation. Considerable variation in methods is shown by the replies given by 27 manufacturers.

German Society of Glass Technology. ANON. *Diamant*, **48** [35], 681–84 (1926).—A brief review of papers presented at the 6th Glass Technologic Meeting in Berlin, Nov. 25 and 26, 1926. The following papers are briefly abstracted: "Chemical Resistance of Glasses," by G. Keppeler; "Effect of Moisture in the Processes of Glass Production," by W. E. S. Turner; "Measure of Quantities of Generator Gas in Conduits under Low Pressure," by G. Wünsch; "Arrangement and Packing of Glass Ware," by G. Gehlhoff; and "Electrolytic Chrome Plating of Glass Molds and Cylinder Material," by K. Illig. E.J.V.

Conflict in the plate glass industry. ANON. *Diamant*, **48** [35], 686–88 (1926).—The impending isolation of machine-glass producers is discussed, with an enumeration of such producers. The Libbey-Owens Works production provides for about one-half of the German consumption. The type and amount of glass produced there is discussed. The Libbey-Owens and Fourcault methods, the latter used by the Bonn Union, as a competitor of Libbey-Owens Works, are compared and their different features discussed. E.J.V.

Glass fabrication by volume production. P. M. G. *Diamant*, **48** [36], 701–704 (1926).—The revolutionizing of glass production methods by Henry Ford in his plant near Pittsburgh is discussed. The disregard of warnings that they were impossible and faith in the new methods devised are taken up. The increased production under the new régime with the new process is pointed out. The testing of other methods in a small plant at Highland Park followed by the erection of a large plant at River Rouge proved that the continuous process could be used successfully. A detailed account of the various steps in this new process of producing plate glass on a volume production basis is given. E.J.V.

Kinon glass D. R. P. ANON. *Diamant*, **48** [36], 706–708 (1926).—A discussion of a nonsplintering glass produced by the glass manufacturer, N. Kinon, of Aachen, and others. It is in reality a combination of glass and celluloid in the form of 2 glass plates with an intermediate layer of celluloid to which they have been joined by a light heating treatment just sufficient to cause a unification of the 3 layers into one. The uses to which this glass can be put are listed. E.J.V.

The increase of the Russian glass industry. FALCONIERI. *Diamant*, **49** [1], 4–6 (1927).—A list of the glass manufacturers in Russia who are building new plants or are enlarging their old ones is given, with the data on the increased size and production which will be obtained thereby. E.J.V.

Mirror coating metals for special purposes. W. H. *Diamant*, **49** [1], 6–8 (1927).—Methods and chemicals used for silvering mirrors of various types and for various special purposes, such as concave mirrors, mirrors for use at high temperatures, or mirrors for experimental purposes, are given. For the production of transparent silver mirrors one allows only a very thin coat of silver to form on the glass and stops the plating before the coating is so thick as to be opaque. The methods given include (1) producing metal sulphide mirrors, (2) platinum mirrors, (3) copper plating of glass according to Chattaway, and (4) metallizing of glass, etc. E.J.V.

Once again Henry Ford. ANON. *Diamant*, **49** [2], 25–26 (1927); reprinted from *Glass Ind.*—A review of the progress made in plate glass production by use of Ford's continuous process. The Allegheny Plate Glass Co. increased its production from

6,000,000 to 8,000,000 sq. ft. of glass per year when taken over by the Ford interests. With the new continuous process developed in Highland Park and used on a large scale at River Rouge, a 33% increase in production with a saving of 25% labor, 13% power, 17% personal supervision and guidance, and 7% actual working time per man, was obtained. E.J.V.

Something on glass substitutes. O-T. *Diamant*, **49** [3], 46–50 (1927).—The idea of glass substitutes may be taken broadly or in a limited sense. They may include Chinese prepared paper, hard paste, mica, or selenite, the photographic film compounds, and more recently, some condensation products which possess properties similar to glass. These latter include Pollopas, invented by Fritz Pollak, which is produced as a condensation product of urea and formaldehyde; the English "Windolite," which is a cellulose acetate and transmits ultra-violet rays; a phenol-formaldehyde condensation product, invented by Pierre Charpentier, into which films or plates of gelatin or cellophane or celluloid are dipped and then dried at 85°; and an American substitute made by saturating cotton tissue with sodium silicate, drying, and coating it with a mixture of paraffine and carnaubic wax. E.J.V.

Practical dissertation on the industry of mirror production. ARTHUR LAURENT. *Diamant*, **49** [3], 52–53; [4], 67–68; [5], 84–85; [6], 102–103; [8], 142–44; [9], 170–73; [13], 247–48; [17], 328–29; [18], 341–43, [27], 529–30; [28], 542–44; [29], 567–68 (1927).—Glass for mirror production must be free of all sorts of flaws and defects. The tin salt treatment of the glass is very important though it is an almost instantaneous affair, as it forms the 1st preliminary condition for the stability of the coating. With wrong tin-salt treatment one can see flaws after 12–24 hours. The coating process takes place in periods varying from 1 to 12 minutes according to the strength of the solutions used, thickness of coating desired, etc. A good coating will be obtained if 3½ g. of silver per sq. meter of glass are used. The lacquer is an important screen and protection for the coating. A good covering lacquer must be dry in a minimum of 15 minutes. Shellac is of more harm than good on unwarmed mirrors, due to its peculiar nature. The lacquer is made up as a solution of 100–150-mesh lacquer in benzine, toluol, or benzol. The polishing process is described in detail. Apparatus and materials used in polishing are enumerated. Details of all the processes of silvering and polishing, grinding, decorating by cutting, and drilling, are given very fully. Methods of classifying mirrors according to quality, type, etc., are explained. The methods of examining the glass and also finished mirrors for defects are also explained. E.J.V.

Glass fabrication by the Fourcault system in China. ST. *Diamant*, **49** [7], 125–26 (1927).—A description of a glass plant in Chinwangtao, China, which operates 8 Fourcault machines and in normal times makes, on a daily average, 500 cases of 100 feet each. The company was organized in 1924 with an initial capitalization of 4,000,000 francs which was afterward raised to 12,000,000 francs. E.J.V.

The plate glass casting process according to Bicheroux. A. WENDLER. *Glass Ind.*, **8** [10], 231–38 (1927).—To Lucas de Nehou, manager of a French mirror glass factory producing blown sheet glass, belongs the credit of introducing the revolutionary change of casting plate glass. Full description of methods used and difficulties encountered are described. E.J.V.

The flow of glass in tanks. II. D. J. MCSWINEY. *Glass Ind.*, **8** [11], 255–58 (1927). —The viscosity of glass in a tank is never the same throughout, but, instead, it may vary greatly; the rate of flow of the glass in different portions of the tank will then show corresponding variations. There is normally no abrupt variation in viscosity or rate of flow in any portion of the tank, but, on the contrary, the viscosity, and consequently the rate of movement, changes gradually from one section to another. The lines of flow will not only vary with the construction of the tank but the flow of glass in any

particular tank will vary greatly, depending on the rate of viscosity changes through the tank. Under definite furnace conditions, the greatest differences in viscosity obtaining in a tank are those which result from differences in color; this is owing to the influence exerted by color on the radiant heat-transmitting power of, and, consequently, the temperature drop through, the glass. As a result of the difference in rate of temperature drop downward through the glass, the channel of flow in a flint or light-green glass may be nearly the full depth of the tank in the center, decreasing in depth toward the sides, especially toward the corners, while the flow in a dark-colored glass is much more shallow and may be confined to within a few inches of the surface, the depth varying with the ability of the glass at high temperatures to transmit radiant heat. The flow in the refiners of glass tanks is more varied than that in the melters, owing to the greater variety of outlets from the refiner, and the variation in amounts of glass drawn through the separate outlets. Variations in the furnace pressure (brought about by varying the stack draft) have the greatest influence on the refiner temperature. A factor which has considerable influence on the lines of flow in the refiner is the temperature of the glass entering the refiner through a throat relative to that of the glass already in the refiner. The use of skimmer blocks or of deep boots does not entirely prevent the flow of surface glass into the boot or trough; in fact, with dark-colored glasses, and after the flow has been in progress for some time, nearly as much surface glass will be drawn without the skimmer as with it. With light-colored glasses, the amount of surface glass drawn is less, but still considerable. The rounding out of the corners of the melter and refiner to give a stream-line effect has at times been proposed and practiced to some extent in England. It would seem logical that the depth of tanks at all points should be such that the glass near the bottom would, under normal operating conditions, have a temperature low enough to prevent any pronounced block attack, but also high enough to obviate the formation of any weak natured glass. This would necessitate the use of much more shallow tanks for dark-colored glasses than is at present customary and would mean that the refiner should be more shallow than the melter. Rounding off the corners of the surface of the melter would result in a decrease in the effective melting area of the tank, as some melting and refining takes place here. E.J.V.

Surface tension as a factor in the forming of glass. Roy E. Swain. *Glass Ind.*, **8** [11], 259–60 (1927).—When glass is allowed to cool from the molten to the solid state without coming in contact with anything other than the atmosphere, it has a very smooth surface. This surface is pleasing to the eye, does not soil easily, and is easily cleaned. The glass worker in obtaining the desired form or shape for the article is always on the alert to prevent the molten glass coming in contact with anything unnecessary. Many methods and treatments have been devised for decorating glass ware but good glass carefully made does not depend upon the decorator's art to make it beautiful. The beauty that lies within good glass can best be appreciated only when the article has a high grade surface finish. The most desirable finish in this respect is the natural fire finish, obtained by permitting the glass to congeal or set without coming in contact with anything other than the atmosphere. This finish owes its beauty to the surface tension of molten glass. The glass worker may not be able to measure surface tension and at times may be at a loss to determine just what part it plays in certain operations but experience has taught him its existence and many ways of using this property of molten glass in the performance of his duties. E.J.V.

Spectral characteristics of light sources and window materials used in therapy. W. W. Coblentz. *Glass Ind.*, **8** [11], 263–67 1927).—The successful use of light in therapy will depend upon a thorough understanding of the physical properties of the source of thermal radiation, as well as the physiological reaction of living matter when exposed to it. Except for the question of intensity and wave-length, physically there is

no marked distinction between the various regions of the spectrum called "ultra-violet", "visible," or "infra-red." Chemically and physiologically there is a distinct difference. The action of infra-red rays is thermal and instantaneous, producing a burning sensation when the intensity is too great. On the other hand, the ultra-violet rays are actinic; that is, they cause the precipitation of albumin. Their action is slow and insidious, so that the effect is not perceived until some hours after exposure. Far ultra-violet has a spectral range of 180 to 290 mμ. This part of the ultra-violet spectrum is easily produced by some of our artificial sources, but is entirely absent in sunlight. The arc between electrodes of nickel, aluminum, and iron, also these metals in the arc of cored carbons, the mercury arc in a quartz burner, and the high potential spark between electrodes and magnesium, of zinc and of aluminum, are rich in ultra-violet rays of wave-lengths 180 to 300 mμ. The action of these rays may be photochemical, just as it is in the activation of food, producing in the blood stream an active substance that has the same function as activated food in the prevention of rickets. Near ultra-violet has a spectral range of 290 to 365 mμ. In the spectral region of 290 to 315 mμ the solar radiation at sea level, during the noon hours, amounts to about 3% of the total incoming rays. The range of 290 to 320 mμ has been called the "health giving rays" or the "vital rays". Some germicidal power has been produced by sunlight transmitted through glass. However, the action was found to be much slower than that of the rays of wave-lengths extending from 180 to 310 mμ. This is, no doubt, the region of solar spectrum that has the greatest therapeutic action, especially at sea level. Visible spectrum has a range of 390 to 760 mμ. The therapeutic action, if any, of these rays (and of the ultra-violet spectrum between 365 and 390 mμ) is largely undetermined. They are present in great abundance in daylight. Near infra-red has a range of 760 to 1500 mμ. It is well known that water in thickness of 2 to 3 mm. is opaque to radiation of wave-lengths longer than 2000 mμ, and in thickness of 10 mm., it is entirely opaque to wave-lengths longer than 1400 mμ. By reflection and scattering of the rays by the red corpuscles, some radiation of wave-lengths at 650 mμ enters the blood stream. Hence, we conclude that the rays of the wave-lengths of 760 to 1500 mμ (or perhaps to 2000 mμ) are the only ones that can penetrate deeply into the blood stream. The physiological action in phototherapy is probably thermal by action on the nerve centers rather than photochemical, as obtains in the short ultra-violet rays. Far infra-red has a range of 1500 to 15,000 mμ. Thermal radiation of wave-lengths greater than 15,000 mμ are emitted by radiant heaters, but for therapeutic purposes the long wave-length limit may be placed at this value. The physiological action is probably thermal (by stimulation of the nerve endings in the skin), instead of photochemical. The usefulness of the new glasses that have a high transmission of the short wave-length ultra-violet rays for windows of solariums, sun parlors in hospitals, etc., where the nude or partially nude body can be exposed is admittedly an important forward step in light-therapy. A few years ago the only medium available for windows transmitting short wave-length ultra-violet solar radiation shut out by window glass was fused quartz at prices that prohibited extensive use even in sanatoriums, hospitals, etc. Now we have new glasses and glass substitutes ranging from material that is but little better than window glass to the better grades, such as "Vioray," "Bretlet," and "Vitaglass," which transmit 40 to 60% of the short wave-length ultra-violet rays (the so-called "Vital rays") that are absorbed by window glass, and finally we have the "Corex" glass which transmits 90 to 92% of these so-called "Vital rays". The ultra-violet spectral transmission of Quartz-Lite, also Amerlite glass, which is of recent production, show the rapid development of new glasses that are somewhat more transparent to ultra-violet than ordinary window glass. The various samples examined transmitted but little more than a sample of window glass The infra-red transmission is high, like window glass, at 3000 to 4500 mμ. The best samples of Vitaglass have a fairly high transmission (20%) at 280 mμ in the ultra-violet. The

infra-red spectral transmission of Vitaglass is relatively high at 3000 to 4500 mμ. The ultra-violet transmission of a newly-developed colorless glass, Corex G. 980A, exceeds all other glasses yet examined and rivals quartz in transparency in the spectral region of 260 to 300 mμ. The transmission of Corning G. 980A is high throughout the infra-red to 2000 mμ, beyond which wave-length it abruptly becomes very opaque, as previously observed in Pyrex glass. Presumably, by dissolving coloring matter in glass G. 980A, several remarkable filters for transmitting ultra-violet radiation are produced. They offer a ready means for isolating ultra-violet radiation for biological and other investigations. Unfortunately, as yet no screens have been produced which absorb all the infra-red. Some years ago Schott of Jena produced a new glass, Uviol, which is transparent to ultra-violet radiation of wave-lengths shorter than transmitted by window glass. E.J.V.

Easily fusible glasses, enamels, etc. ANON. *Pottery Gaz.*, **52** [604], 1629–30 (1927); reprinted from *Glashütte*.—In the glass and ceramic industry, and also in the technical lighting branch, glasses and enamels are frequently required to have a very low melting temperature; *e.g.*, for the application of coatings to incandescent lamp bulbs. Most of the enamels melting at a low temperature used for this purpose possess a very high percentage of lead oxide, amounting to about 80%. This high percentage always necessitates a more or less heavy tinting of the glass, causing a yellowish hue, which on the one hand detracts from the appearance of the glass, and on the other hand also diminishes the amount of light passing through it. The object of a recent German invention is to permit the production of a glass melting at a low temperature, in which this yellowish tinting, caused by a high percentage of lead oxide, is avoided. For this purpose, according to the invention, to a glass mixture of composition having a low content of lead oxide (about 40–60%), there are added at least 8–16% alkali-silico-fluoride in addition to the other usual glass-forming substances such as boric acid and silicic acid. The addition of alkali-silico-fluorides to glass is already known *per se*, but heretofore these alkali-silico-fluorides have only been added to glasses of an entirely different composition and also always merely in very small quantities of, at most, 6% with a view to their acting as a "clouding" medium. In the new glasses and enamels, however, with the predetermined diminished lead-oxide percentage, the quantities of alkali-silico-fluoride introduced in a larger proportion serve as a glass-forming medium. Upon melting, a certain amount of evaporation takes place of the alkali-silico-fluorides introduced into the glass compound, this depending upon the temperature and composition or selection of the other glass-forming components. It has, however, been found that considerable quantities of the alkali-silico-fluorides added (as a rule from 50 to 80% thereof) are still to be found in the finished enamel. This is probably due to the reason that the largest part of the alkali-silico-fluorides as glass-formers pass over into solution, and that upon the melting of the enamel substantially lower temperatures are necessary than with the usual technical glasses and enamels. Briefly, this process for the manufacture of easily fusible glasses and enamels is characterized by the fact that a mixture of composition is melted which, in addition to containing from 40–60% lead oxide and the necessary glass formers, such as boric acid, silicic acid, and, if necessary, also zinc oxide, also contains from 8–16% alkali-silico-fluoride. Lithium-silico-fluoride, either alone or mixed with other alkali-silico-fluorides, may be added to the mixture. E.J.V.

The glass industry of Czechoslovakia. ANON. *Ceram. Ind.*, **9** [5], 542–52 (1927).—The history and developments of the glass industry are given. Its development has indirectly exerted a certain influence on similar industries, notably the chemical and ceramic industries. The primary chemical materials necessary for the manufacture of glass, except red-lead and certain other ingredients, are furnished by the factories of

this country. The refractory materials used in the construction of the furnaces, not taking into account some special grades of refractories, are furnished by the country's ceramic factories which are highly developed, the country producing the raw materials required in that industry. Germany supplies the pot clays. The sand required for glass making is to be found in abundance in this country as are the quarries of chalk and limestone. The crystal industry has long made use of sand imported from Saxony. The country boasts 154 glass manufacturing establishments. Mechanical fabrication is concentrated in the region of Teplice. The glass industry, however, relies principally on manual labor. Composition glass, which is difficult to mold in a semiliquid state, is worked exclusively by the workers in their homes. In the interest of the country and particularly the workers, it is desirable that nothing but the finished product be exported. The workers are strongly organized. There are several technical institutions and schools engaged in scientific research work on the quality and composition of glass and the employment of raw materials and at the same time offer efficient instruction along chemical lines. F.P.H.

Liven up sales with colored glass containers. THEODORE LENCHNER. *Ceram. Ind.*, **9** [5], 555 (1927).—It is shown how containers made of colored glass or with vitrifiable colors fused to the glass in attractive designs create greater sales possibilities. F.P.H.

Finding costs in the glass plant. E. J. BORTON. *Ceram. Ind.*, **9** [5], 556–57 (1927).—Cost finding methods as applied to the glass industry exclusively are discussed. F.P.H.

New bottle transfer machine. ANON. *Ceram. Ind.*, **9** [5], 557 (1927).—A new type of transfer machine is said to be in operation in a German glass plant. Drawings are given showing how the setting machine is set up. The leer is evidently on a lower level than that of the tank with which it is connected as the bottle slides on a trough and into the leer. According to the information received, the leer will handle various-sized bottles within certain limits of heights. It is said that the bottles must be within certain narrow limits for the transfer machine to operate with greatest efficiency. F.P.H.

Automobile glasses. E. WARD TILLOTSON. *Ind. Eng. Chem.*, **19** [10], 1099–1101 (1927).—A discussion of the various glasses used in automobiles with special reference to the manufacture of plate glass. It is pointed out that plate glass constitutes one-fifth of the value of the entire glass industries and that the automobile utilizes about one-half of the plate glass manufactured in this country. R.J.P.

Extending the life of chemical glass ware. J. T. LITTLETON, JR., AND G. A. DASNEY. *Ind. Eng. Chem.*, **19** [11], 1271 (1927).—A caution to users of chemical glass ware that glass of good quality can be abused in laboratory use. Improper application of the glass ware, sharp-pointed flames, and scratching are mentioned as causes for failure of chemical glass ware. R.J.P.

A large bottle blowing machine. ANON. *Engineer*, **144** [3729], 3–6; [3730], 48–49 (1927).—For abstract see *Ceram. Abs.*, **6** [11], 508 (1927). G.W.W.

Developments in glass melting furnaces. W. E. S. TURNER. *Fuels and Fur.*, **5** [10], 1377 (1927).—Discussion in the development in design and operation of pot and tank furnaces. Abstract of paper at recent meeting of Society of Glass Technology, England. A.E.R.W.

Transmission of vitalizing rays by glass and glass substitutes. ANON. Bur. Stand., *Tech. News Bull.*, No. 126, p. 4 (1927).—All the new glasses for transmitting the ultra-violet "vitalizing" or "activating" solar rays at 290 to 310 millimicrons, undergo a photochemical action and decrease greatly in transparency to these activating rays when exposed to ultra-violet radiation. Abstracted in *Ceram. Ind.*, **9** [5], 570 (1927). R.A.H.

Fine annealing of optical glass. ANON. Bur. Stand., *Tech. News Bull.*, No. 126, p. 7 (1927).—Description of the apparatus used in annealing of optical glass and discussion on necessity of close control of temperature and time in this process. R.A.H.

Production defects in glass. LUDWIG SPRINGER. *Sprechsaal*, **60** [28], 498–502; [29], 517–19; [30], 534–36; [31], 556–58; [32], 576–78 (1927).—Various defects of plate, mirror, and hollow glass ware are analyzed; composition of glasses given; possible causes of defects and discussion on elimination of them. R.A.H.

Chemical engineering contributes to better lighting. M. PIPKIN. *Chem. Met. Eng.*, **34,** 660–63 (1927).—Inside frosting of incandescent lamps is done in 2 stages. (1) Etching is done with one solution and (2) the etched surface is then strengthened by treatment with a similar solution of lower concentration. The etching solution is composed of hydrofluoric acid (60%) 37.3, ammonium bifluoride 29.0, ammonium carbonate 12.4, soda ash 6.2, water 15.1. The fortifying solution is made by adding 3 parts water to the above mixture. A description of the mechanical apparatus used is given, with photographs. M.E.M.

The internal life of glass. A. LECRENIER. *Chim. et ind.*, (Special No.), 140–50, May, 1927.—An address discussing the effects of temperature, composition, light, Ra, and electricity on the internal changes undergone by glass. (*C. A.*)

The viscosity of glass. EMILIO DAMOUR. *Chim. et ind.*, (Special No.), 441–42, May, 1927.—Description of the Garvin viscosimeter for measuring the viscosity of glass at the point of incipient fusion. (*C. A.*)

The use of sodium carbonate and sodium sulphate in the manufacture of glass. A. LECRENIER. *Chim. et ind.* (Special No.), 443–45, May, 1927.—Discussion of the functions of Na_2CO_3 and of Na_2SO_4 in glass making, and of their relative merits and disadvantages. (*C. A.*)

Raw materials of the glass industry. J. B. KRAK. *Glass Ind.*, **6,** 98–100, 123–25, 143–45, 190–94 (1927).—A general discussion of the occurrence, or manufacturing methods of winning, purification, uses, and behavior of the raw materials used in the making of glass. (*C. A.*)

Bottle making in Indo-China. DONALD ROBERTSON. *Glass Ind.*, **6,** 115–19 (1927). An account of the glass manufacturing conditions in the Far East. (*C. A.*)

Proposed specifications for glass-making sands. ANON. *Glass Ind.*, **7,** 37 (1926).—Specifications covering the general character, sizing, and composition of glass sands are given. The allowable impurities range from 0.1% Al_2O_3, 0.02% Fe_2O_3, 0.1% CaO plus MgO in first quality optical glass to 4.0% Al_2O_3, 1.0% Fe_2O_3, 0.5% CaO plus MgO in 9th quality amber glass. (*C. A.*)

Strain and the hot-water test for bottles. D. J. MCSWINEY. *Glass Ind.*, **7,** 261–63 (1926).—The resistance to thermal shock is slightly higher for unannealed than annealed ware. Strongly and uniformly strained ware has about double the resistance to internal hydraulic pressure that it shows when well annealed. (*C. A.*)

Electrolysis of glass. I. HANS HURTER. *Helv. Chim. Acta*, **9,** 1069–73 (1926).—A study was made of electrolysis through glass according to the method of R. C. Burt to prove that Na followed Faraday's law. Spectrum analysis showed that K also can be electrolyzed through glass. The substitution of the Na ion in glass by the K ion was pursued quantitatively, proving the validity of Faraday's law. (*C. A.*)

Researches on the ion exchange of glasses. KARL HOROVITZ AND JOSEF ZIMMERMAN. *Sitzb. Akad. Wiss. Wien*, (*II*) **134,** 355–83 (1925).—Certain German resistance glasses take from H_2O solution some metallic ions, especially Ag, to the extent of becoming reversible electrodes. By precipitating the Ag with chloride, conditions similar to an acid-alkali chain are produced. For every glass and ion a definite concentration

of solution is necessary to obtain the reversible electrode effect. Attempts to study ion exchange in calcite and barite crystals in contact with solutions were not successful because of minute cracks in the crystal. The results of H. and Z. were confirmed by M. J. Mulligan, tests in which Ag was deposited in glass when glass tubes filled with $AgNO_3$ solutions were used as electrodes. (*C. A.*)

The manufacture of incandescent lamp bulbs by entirely mechanical methods. A. KARSTEN. *Z. Ver. deut. Ing.*, **71**, 1227–30 (1927). (*C. A.*)

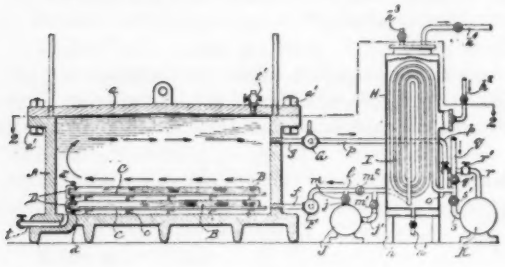
BOOKS

Defects in Glass. By C. J. PEDDLE. 230 pp. Glass Publications Ltd., London, 1927. Price 8*s* 6*d*. Reviewed in *Ind. Eng. Chem.*, **19** [11], 1299 (1927).—For abstract see *Ceram. Abs.*, **6** [10], 485 (1927). R.J.P.

English and Irish Glass. W. A. THORPE. 10x7¾, xii+35 pp., 60 plates. London: The Medici Society, 1927. Price 17*s* 6*d*. Reviewed commendingly in *Times Lit. Supp.*, Oct. 27, 1927.—Contains 6 colored plates, an historical development of the craft, various summaries of "features," and a glossary of technical terms. H.H.S.

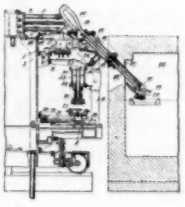
PATENTS

Apparatus for making laminated glass. EDWARD S. BOCK. U. S. 1,645,580, Oct. 18, 1927. In an apparatus for producing laminated glass, a pressure chamber, a flexible unitary nonmetallic container, and a substantially rigid platform upon which the container is supported, the platform being substantially coextensive with the unitary container and the platform being insertible as a unit with the container into the pressure chamber.

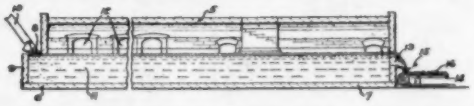


Method and apparatus for manufacturing glass ware. WILLIAM EMIL BOCK. U. S. 1,645,684, Oct. 18, 1927. (1) In an apparatus of the class described, a forehearth in communication at its inner end with a source of molten glass supply and having inner and outer body sections coöperating to form a glass-discharge slot in the forehearth bottom, means carrying the forehearth for vertical adjustment to vary the speed of flow of the glass to the discharge slot and means for adjusting the outer section toward and from the inner section to vary the width of the slot. (2) In a glass-working apparatus, means to hold a supply of molten glass from which a glass sheet is formed, and cooling blankets disposed at opposite sides of the sheet and moving therewith to effect a forced cooling of the sheet.

Gathering means for glass-working apparatus. AUGUST KADOW. U. S. 1,645,755, Oct. 18, 1927. In a machine of the class described, a gathering unit including a ram, fluid controlled means for imparting reciprocatory movements to the ram, a gathering head movably carried by the ram and normally standing in one position of its movement relative thereto, and means dependent upon movement of the ram and automatically operable to move the head to a different predetermined position relative to the ram when the ram is at a predetermined point in its movement relative to the control means.

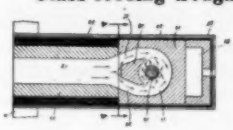


Process for forming sheet glass. THOMAS C. MCKINLEY. U. S. 1,646,488, Oct. 25, 1927. That step in the process of producing a glass article, consisting in forming a molten source of supply from cullet only.



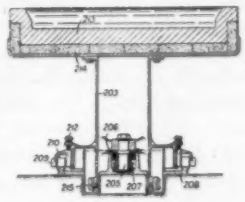
Glass-blowing machine. EDWARD H. LORENZ. U. S. 1,647,532, Nov. 1, 1927. In a glass-shaping machine including a mold, the combination of a support having a curved recess therein, and a blowhead having a portion shaped for movable engagement with the recess, and a portion shaped for sealing engagement with the mold, the latter portion of the blowhead being located between parallel planes disposed normal to the axis of the blowhead and tangent to the sphere defined by a continuation of the curve of the recess.

Glass-feeding trough. JOHN RAU. U. S. 1,647,541, Nov. 1, 1927. A feeder block for glass-feeding mechanism, including a chamber having a discharge outlet near the lower end and in spaced relation from the walls of the chamber, and a plurality of divergingly directed passages having tangential discharge into the chamber at diametrically positioned points of tangency.



Multiple glass feeder. KARL E. PEILER. U. S. 1,647,746, Nov. 1, 1927. An apparatus for feeding molten glass, the combination of a carrier, a series of rotating gathering implements mounted thereon in substantially radial relation, and mechanism for revolving the implements successively into and out of contact with a supply of molten glass to obtain gathers therefrom while preserving the radial relation.

Rotary glass tanks. S. J. SELLAR. Brit. 275,138, Sept. 21, 1927. A rotary pot or tank for use in association with a glass-gathering machine is mounted on a hollow column having an internal stud resting in a footstep bearing, and carrying externally a number of slides which can be adjusted by screws to level the tank. The footstep bearing comprises roller and ball races mounted in a spherical seating, and the rollers carried by the slides run on a circular track cast integrally with the bearing support. The tank is lined with refractory and insulating material and is rotated by a worm gear.

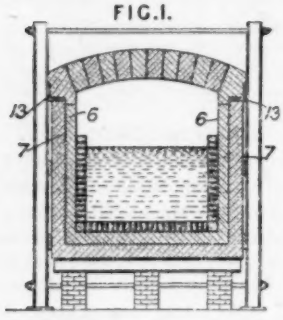


Forming silica-glass articles. G. CHANEL. Brit. 275,141, Sept. 21, 1927. A method of making ornamental objects, such as cups or animals, from quartz or from low-expansion glasses consists in welding together the parts of the object by means of an oxy-hydrogen blowpipe and subjecting the welded spots to local annealing by means of a gas blowpipe. The parts of the objects may be made by blowing, pressing, or other suitable operation.

Glass manufacture. PITTSBURGH PLATE GLASS CO. Brit. 275,169, Sept. 21, 1927. Apparatus for making sheet glass comprises rolling means for forming the molten glass into sheets at relatively high speed and an annealing leer for receiving the sheets provided with transporting rollers arranged in separately driven groups which at the forward end of the leer are driven at high speed until the sheet is sufficiently set, after which they are driven at a reduced speed corresponding to the speed of the rollers in the rear section of the leer. Indicating means governed by the sheets are provided for informing the operator of the position of the ends of the sheets as they pass through the forward section of the leer.

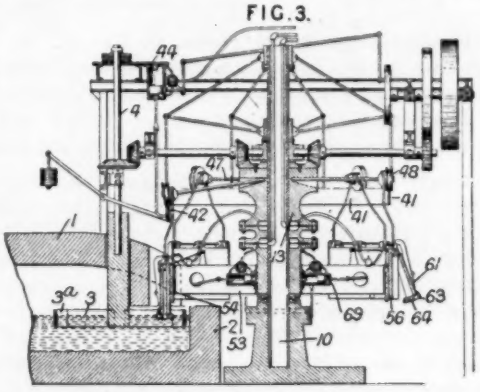
Furnaces. HARTFORD-EMPIRE CO. Brit. 275,555, Sept. 28, 1927. The inner walls and bottom in contact with the glass are composed of relatively small highly refractory blocks united by a luting into a monolithic structure. The blocks are preferably composed of combined silica and alumina vitrified at a temperature exceeding 2750°F and are preferably formed with inter-engaging corrugations; the luting is preferably a slip composed of the same materials which when the furnace is heated firmly unites with the blocks. There is an intermediate wall (6) of ordinary refractory blocks and an outer wall (7) of fire brick or insulation. Angle beams (13) secured to the buckstays carry the skew blocks of the crown.

FIG. 1.



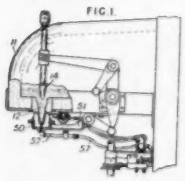
Glass manufacture. H. J. HAYS. Brit. 276,517, Oct. 19, 1927. Plates or sheets of glass are made by molding, the molten glass being gathered into the molds by suction. A machine for carrying out the invention comprises a stationary hollow column (10), about which a framework rotates. The frame carries a number of molds (54) which are brought in turn above an open forehearth (2) of a tank furnace (1). The metal in the forehearth is skimmed and is constantly agitated by a rotary paddle member (3), having an annular rim (3^a), which is mounted at the lower end of a shaft (4) rotated in unison with the machine. Each mold slides vertically in guides formed in a member (53) of the machine frame, and it is supported by a radial shaft (47). In operation, a mold is closed when it is dipped to gather a charge, and when it is filled with metal, the plate (61) is drawn closer to the plate (56) thus causing the glass to fill the mold completely and squeezing out any surplus metal through the slot (64). The bottom (63) is moved outward, as the mold is raised, to cut off any excess of metal. When the mold has been carried by the rotation of the machine to a point opposite the forehearth, it is opened and discharges the molded glass plate.

FIG. 3.



Glass manufacture; delivering molten material. S. DUNLOP. Brit. 276,556, Oct. 19, 1927. A feeder is provided with a device which momentarily supports and shapes the column of glass as it issues from the outlet, the device being moved clear of the glass before it has appreciably chilled. The feeder comprises a forehearth (11) projecting from a tank furnace, and the metal issues from an outlet (12) in the floor of the forehearth. The discharge of the metal is assisted by the reciprocations of a plunger (14) and the issuing column of metal is cut into "gobs" by shears operating close beneath the outlet. According to the invention, the end of the column is supported for a short time by a cup (50) carried by a lever (51), which is swung upward close against

FIG. 1.



the outlet (12). The cup also shapes the end of the issuing column of metal, and to assist this operation, suction is applied through a pipe (57) to the lower end of the cup. As soon as the column of metal is shaped, the cup is swung downwards and a "gob" is cut off by the shears.

Glass manufacture. R. HADDAN. Brit. 276,606, Oct. 19, 1927. A method of making blown-glass articles consists in forming a flowing stream of glass into a ribbon, depositing the ribbon on a conveyer formed with apertures, allowing part of the ribbon to sag through the apertures, and then blowing in molds the parts of the glass that have sagged through the apertures, the ribbon and molds being in continuous movement during the blowing operation. The molten glass flows in a continuous stream (78, Fig. 46), from an aperture in a forehearth attached to a tank furnace, the rate of flow being controlled by a plug. The stream (78) passes between water-cooled rollers (71, 72), by which it is flattened into a ribbon (79). The ribbon is deposited on a continuously moving conveyer (150), consisting of a series of plates (153), carried by the links of an endless chain which moves in an horizontal plane. In an alternative construction, two sets of plates are carried by similar chains so arranged that pairs of plates come together end to end below the rolls (71, 72), and move forward as though they were single plates. Each plate is formed with an aperture (156), and as soon as the ribbon is deposited on the conveyer, the glass over the aperture commences to sag downward. The edges of the apertures limit the amount of glass which is available and also serve to anchor the ribbon on the conveyer. The travel of the conveyer brings the ribbon under the run of an endless chain of blow heads (202), which, during the lower part of their run, make contact with the underside of a blow box (201). The blow heads are pressed into contact with the glass ribbon above the apertures (156), and are supplied with air in regulated quantities from the blow box by means of valves or ports. The sagging glass expands progressively and each bulb so formed is enclosed in a mold (280). The apparatus is intended particularly for the production of electric lamp bulbs, although it can be adapted for the production of other kinds of ware. The molds (280), are carried by an endless chain moving in a vertical plane; they are provided with means for opening and closing them automatically. They are also provided with means for rotating them while they are closed in order that the finished ware may have a high finish and be free from mold marks. When a bulb is blown, the mold opens and moves downward (Fig. 47), the blow heads are lifted and move upward, and the bulbs continue to move forward suspended from the conveyer. A disk (352), strips the glass ribbon from the plates of the conveyer and the bulbs are knocked off by an arm (354). An air blast is provided to cool the blow heads, and jets of water are sprayed on to the molds and conveyer plates during the inoperative parts of their run.

FIG. 46

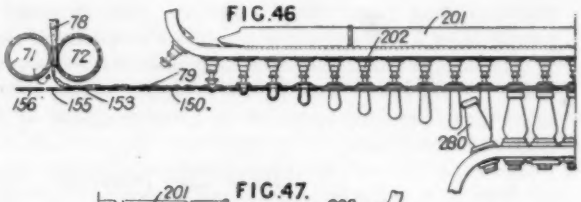
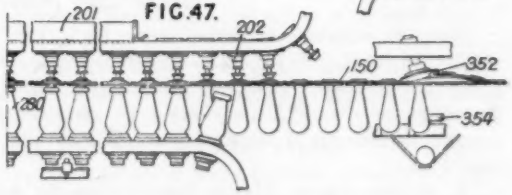
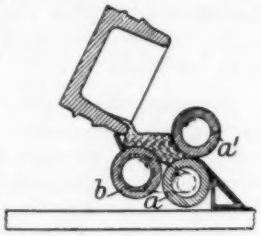


FIG. 47.



Glass manufacture. M. BICHEROUX. Brit. 276,662, Oct. 19, 1927. Relates to a method of making plate glass and consists in depositing the mass of molten glass on a feeding-roll (*b*), which is arranged in front of the forming-rolls (*a*, a^1), instead of depositing it on a teeming-plate. The roll (*b*), is driven by the roll (*a*), and at a lower circumferential speed, so that the glass does not sink into the space between the rolls.



Glass manufacture. M. BICHEROUX. Brit. 276,663, Oct. 19, 1927. Relates to a method of making plate glass and consists in depositing the mass of molten glass on the forming-rolls in a receiving space defined by these rolls and by additional rolls arranged above them. The rolls are adjustable about the axes of the forming-rolls, and each may be rotated in the same sense as the corresponding forming-roll in order to assist in feeding the glass to the pass between the forming-rolls. The feeding action may be assisted by forming the rolls with flutes or ribs. Instead of the single roller, 2 or more feeding-rolls may be used to receive the glass.

Heat-absorbing glass. W. C. TAYLOR. Can. 272,685, July 26, 1927. A heat-resisting glass of low coefficient of expansion and of high absorption of the infra-red, has a high silica content, and contains potash, lithia, B_2O_3, and FeO. (*C. A.*)

Glass. M. PERNET. Can. 273,537, Aug. 30, 1927. In the manufacture of Na-Al-B-silicate glass, the Al is added to the glass compound as Al sulphite and the B as crystallized borax. (*C. A.*)

Heavy Clay Products

Some experiments in drying clay. R. S. TROOP AND F. WHEELER. *Brit. Clayworker*, **36** [426], 208–13 (1927).—The specific studies on clay drying covered in this paper are (1) contraction, and the influence of rate of drying and shape of the clay article on same; and (2) the effect of the physical conditions of the drying medium on the rate of removal of moisture from the clay, and on the distribution of moisture in the shape. R.A.H.

U. S. Government Master Specification for hollow tile, clay, load-bearing wall. Bur. Stand., *Circ.*, No. 342 (1927).—This specification is applicable to hollow units of fired clay intended for load-bearing purposes in walls and piers, and are classified as: *H*, hard; *M*, medium; and *S*, soft. Color cannot be taken as indicative of classification. Tile under this specification shall be of fired surface clay, fire clay, shale, or mixtures thereof. Tile shall be sound, well fired, free from large drying or firing cracks, reasonably free from laminations, and without excessive warpings or variations of more than 3% from the specified dimensions. Requirements as to dry weight, absorption, and compressive strength are included. R.A.H.

U. S. Government Master Specification for hollow tile, clay, fire-proofing, partition, and furring. Bur. Stand., *Circ.*, No. 343 (1927).—This specification is applicable to hollow units of fired clay intended for partitions, furring, and protection of structural members against fire, and are classified as *M*, medium and *S*, soft. Color cannot be taken as indicative of classification. Tile under this specification shall be of fired surface clay, shale, or admixtures thereof. Tile shall be free from large drying or firing cracks, reasonably free from laminations, and without excessive warpings or variations of more than 3% from specified dimensions. General requirements as to dry weights, absorption, and compressive strength are included. R.A.H.

U. S. Government Master Specification for hollow tile, clay, floor. Bur. Stand., *Circ.*, No. 344 (1927).—This specification is applicable to hollow units of fired clay intended for load-bearing purposes in floors and which are classified as: *M*, medium and

S, soft. Color cannot be taken as indicative of classification. Tile under this specification shall be of fired clay, fire clay, shale, or admixtures thereof. Tile shall be sound, well fired, free from large drying or firing cracks, reasonably free from laminations, and without excessive warpings or variations of more than 3% from the specified dimensions. Requirements as to dry weights, absorption, and compressive strength are outlined. R.A.H.

U. S. Government Master Specification for common clay brick. Bur. Stand., *Circ.*, No. 345 (1927).—This specification is applicable to common solid or hollow (not face) clay brick of any of the following 4 classes: *V*, vitrified; *H*, hard; *M*, medium; *S*, soft. Brick under this specification shall be of clay, sound, of compact structure, reasonably uniform in shape, free from stones and pebbles that would affect their serviceability or strength, and without excessive laminations or warpings. The standard size of brick shall be $2\frac{1}{4} \times 3\frac{3}{4} \times 8$ inches with permissible variations of $\frac{1}{8}$ inch in width or depth and $\frac{1}{4}$ inch in length. R.A.H.

U. S. Government Master Specification for common sand-lime brick. Bur. Stand., *Circ.*, No. 347 (1927).—This specification is applicable to common sand-lime brick, hard, medium, or soft. The brick shall be of sand and lime hardened by treatment with high pressure steam and shall be sound, of compact structure, reasonably uniform in shape, and reasonably free from lime spots, large pebbles, and balls of clay. Requirements as to dimensions, absorption, and strength are given. R.A.H.

Characteristics of several heavy clays. ANON. Bur. Stand., *Tech. News Bull.*, No. 126, pp. 8–9 (1927).—Although most of the shales included in this investigation show no great variation in grain size and sandiness, the slaking time varies from 4 to 35 minutes. In the alluvial clays the sandiness and grain size vary greatly and the slaking time varies from 10 minutes to several hours. Typical screen analyses of alluvial clay and shale are given. R.A.H.

Clay products for fire safety. ANON. *Brick Clay Rec.*, **71** [7], 474 (1927).—A plea to preach the use of clay products for fire safety in buildings during Fire Prevention Week. E.J.V.

Honest comparison between cost of clay product and frame houses. ANON. *Brick Clay Rec.*, **71** [7], 479–83 (1927).—A survey of costs of house building presented in such a way that it can be used by anyone in obtaining a comparative set of figures in his own locality. There is very little actual difference in the cost of clay product and frame houses of similar size and style. E.J.V.

Loading brick with crane and pallet. ANON. *Brick Clay Rec.*, **71** [7], 487 (1927).—A description of the plant of the Empire Brick and Supply Co., Newton Hook, N. Y., which uses pallets capable of being loaded with about 600 brick, 5 tructractors, an overhead chain hoist, and a swinging type loading crane to load from 70,000 to 150 000 brick daily from its kilns. E.J.V.

Converting a city to brick. ANON. *Brick Clay Rec.*, **71** [7], 490–91 (1927).—An interesting account of how Suffolk, Va., was converted into a city of brick homes through the efforts of H. L. Jacobs of the Suffolk Clay Co., by means of daily advertisements and articles explaining the merits of clay construction. E.J.V.

Over six years' experience using tunnel kiln for soft-mud brick proves process economical. GEORGE RANSOM. *Brick Clay Rec.*, **71** [8], 558–63 (1927).—A description of the plant of the Donnelly Brick Co., of New Britain, Conn., which utilizes practically a complete outfit of labor-saving equipment in the production of soft-mud brick. A Dressler tunnel kiln having a capacity of 50,000 brick per day is used in firing the larger part of the output of the brick machine, with the balance being fired in scove kilns. Both the tunnel kiln and the scove kilns are fired with fuel oil. The effective, smoothly running operation of the plant is accounted for by the compact grouping of

the different buildings, the direct flow of material in all stages, and the full coöperation of all employees. E.J.V.

The effect of water content and pressure of repressing on the porosity of stiff-mud brick. S. M. PHELPS. *Clay-Worker*, **88** [4], 265–67 (1927); reprinted from Amer. Refrac. Inst., *Tech. Bull.*, **11** (1927).—See also *Ceram. Abs.*, **6** [8], 342; [10], 447 (1927). E.J.V.

Factory design and equipment. VIII. T. W. GARVE. *Clay-Worker*, **88** [4], 268–71 (1927).—Feeding and mixing are the topics discussed. Various automatic feeders, including different forms of disk feeders, rotary compartment feeders, reciprocating plate feeder, the James feeder, scoop, screw, and belt feeders, are enumerated and discussed. Machines for feeding and mixing, or mixing only are taken up and their principles explained. For previous articles see *Ceram. Abs.*, **6** [3], 103; [5], 175; [6], 222; [8], 343; [10], 442; [11], 536 (1927). E.J.V.

Stark Brick Co. adopts labor-saving devices. ANON. *Clay-Worker*, **88** [4], 272–73 (1927).—A description of the plant of the Stark Brick Co., of East Canton, Ohio, makers of a high-grade salt-glazed brick and 5-x 8-x 12-inch hollow tile. The arrangement of machinery to obtain maximum efficiency is described. The use of Timken bearings in the majority of cases is stressed in connection with machinery installations. E.J.V.

The Poston method of clay veneering. ANON. *Clay-Worker*, **88** [4], 282 (1927); *Brick Clay Rec.*, **71** [7], 485 (1927).—Clay-products veneering is not a new idea. The Poston process, however, is a new departure which seems practical. It is a patented process, the result of several years of study and experimenting by E. V. Poston. In this method, the granular particles of clay are impinged into the top and sides of the clay column just after it comes from the die, by means of steam pressure. The veneering material can be ground to any desired fineness and is fed into a hopper which has a distributing drum at the bottom. This drum has grooves with slides or shutters which regulate the amount of veneering material to be applied and consequently control the thickness of the surface. The distributing drum is rotated by means of a belt or chain driven from the measuring belt, and thus an exact and uniform thickness is obtained since the rotation of the drum is in accordance with the speed of the measuring belt. The granular material is conveyed by chutes or pipes to the steam jets or nozzles which are located around the top and the 2 sides of the clay column. There are 3 jets above the clay column and 2 to either side at a distance of about 12 inches. The steam is fed into the jet by a pipe coming from a specially designed manifold. It enters a steam chamber and is ejected at a very great speed through an accurately-machined steam ring toward the face of the clay column. Thus it creates a considerable suction or vacuum in the receptacle to which the dry granular veneer particles are conveyed and as the clay particles are drawn by this suction from the receptacle and ejected from the mouth of the jet they are caught in the steam current which carries them with great force and imbeds them into the faces of the plastic clay column. Approximately 50 pounds of steam is desired. The trouble incident to difference in shrinkage of the clay column and the veneering material is practically eliminated by this method; exhaustive tests of clays of the widest shrinkage ratios have never developed the slightest checking or cracking of the veneered surface. The veneered surface is a protection against such checking and tests have shown that the particular texture obtained actually tends to strengthen the exposed surfaces of the brick, reducing greatly the loss due to chipping in handling in the usual process. This method also eliminates the need for scratching or indenturing devices which generally tend to swell or distort the clay column. The veneering covers the entire surface of 3 sides of the brick. It is possible to use the highest grades of clay for veneering purposes at little additional cost since only about

3% of veneering material is used. This will conserve our clay resources and it will make it possible for any stiff-mud brick manufacturer to meet any competition.

E.J.V.

Causes, prevention, and removal of staining of Indiana limestone. H. C. PEFFER. *Eng. News Rec.*, **99** [12], 461 (1927).—P., Engineering Experiment Station, Purdue University, conducted a research on extreme service conditions on 12 different types of limestone in the form of seepage panels. Brown or coffee-colored stains very often appear on the walls of light-colored limestone structures. It is thought that this condition is more common since the use of Portland cement. This color was first attributed to the iron compounds in the cement used; but latest research shows that the trouble is due to colloidal dispersion of organic matter contained therein; the limestone then regains its normal color. This organic matter appears on the surface as a blotch, gaining the surface through the body of the stone by the alkaline leach water from the cement or mortar backing. It is believed that the process of cement manufacture has rendered a certain constituent compound, in the clay used, soluble (probably sodium or potassium hydrate or carbonate) and that this compound presents itself in the leach water as "free alkali." Its presence varies from 0.02–0.05, expressed as per cent Na_2O and produces stains in direct proportion to the percentage present. Two methods were sought to prevent this: (1) by keeping a low "free alkali" content in the cement, and (2) by keeping the structure as dry as possible. The first necessitates a careful selection of the cement to be used. The removal of this stain can be carried out only on the dry structure. A suggested method is a paper stock poultice of a 5–10% solution of wash soda applied to the stained areas for a period of 24 hours. This poultice is then removed and replaced by another of 10% formic acid, which is left in place another 24 hours. No further treatment should be necessary. P.F.C.

Stone preservation. ASTON WEBB. *Eng. News Rec.*, **99** [13], 510 (1927).—A report of a research on the development of protectives or preservatives for the decay of building stones. The investigation consists of a study of the physical and chemical phases of stone deterioration and of the possible biological actions. Microsections are employed to carry on this part of the study. Small piers were built in 1926 of typical building stones and the preservatives then applied. The preservatives tried were paraffin wax dissolved in ligron, sodium silicate, barium monoxide, followed by alum, barium monoxide, followed by arsenic acid, silicon ester, and a zinc magnesium silico-fluoride. The results have not yet been made public. Scott Russell carries on an investigation of new and weathered building stone. Thin sections are again employed, the stone being first impregnated with a Bakelite synthetic resin. The structure of the different limestones was found to vary, depending on the oölitic structure, whether porous or not. Another difference was found, depending on whether the stone was rain-washed or weather protected. It was found that a protected surface became coated with a soot-gypsum cement, and gypsum replacement taking place beneath this cover. An attempt is being made to establish a definite relationship between the gypsum growth and the disintegration of the building stone. P.F.C.

Fire resistance of brick walls under working loads. ANON. *Eng. News Rec.*, **99** [16], 628 (1927).—Extended fire tests of brick walls under load have been carried out by the Bureau of Standards at Washington. The test panels were 16 ft. long and 10 to 11 ft. high and were applied to the side of a furnace, permitting the production and maintenance of temperatures corresponding to the American standard fire test. The panels were mechanically loaded by pressure on steel frames inclosing the brick work. Loads of 80 lbs. per sq. in., for 4-in. walls, and 160 lbs. per sq. in., for thicker walls, were maintained during the tests. Measurements were made of the length of time required to attain an average temperature of 250°F (139°C) on the unexposed side and the time

required for failure under working load. Load failure occurred first only in the case of the 12-inch unplastered walls, built of low-fusion temperature bricks. Plaster, when applied as a coating to the panels, was found in every case to increase the fire resisting properties of the walls. The plaster was gypsum or cement with 3 volumes of sand. Common bond, with a header course for every 5 stretcher courses and the usual "Rolok" and "Rolokbak" bonds were employed in the panel designs. The mortar used was 1:3 cement or cement-lime mortar. Joists and other combustible members, when framed into the walls (to a depth of 4 inches), reduced the fire-resistant period. The Bureau recommends a factor of safety of 1.5; that is, if the service condition of the building is such that a wall should be able to withstand 6 hours of fire conditions, a wall giving a 9-hour resisting period, at least, should be employed. P.F.C.

Kieselguhr as a raw material for heavy clay products. E. STEINHOFF. *Ber. deut keram. Ges.*, **8** [3], 137–74 (1927).—Describes the occurrence of kieselguhr and the geographical distribution of technically important deposits. Three kinds of kieselguhr from various sources are subjected to a series of tests. The structural relations, microscopic examinations, chemical analysis, and fusion points of various types of kieselguhr are described. The fusion points vary from cones 8 to 30. The behavior of kieselguhr bodies in firing is studied. The unfired material shows very little expansion over the range 20–950°C, while the body that has been fired to cone 9 shows a considerable expansion at about 180°C, showing that the kieselguhr has been converted to cristobalite by the firing to cone 9. The following physical tests are carried out on a number of types fired at temperatures varying from 810–1110°C: (1) shrinkage, (2) specific pore volume, (3) cone fusion, (4) strength, (5) temperature at which softening begins under a load of 1.5 kg./cm². The physical properties of light insulating brick made of kieselguhr are given in tabular form. The preparation of insulating brick and refractory light brick is described. Numerous photomicrographs of fired and unfired kieselguhr are given. F.P.H.

Drying and baking of paving brick. GUSTAVE COLIEZ. *Chal. et Ind.*, **8**, 449–55 (1927).—Description of present-day practice in the U. S. (*C. A.*)

PATENT

Method of producing brick and tile. ERIK WILHELM TILLBERG. U. S. 1,647,063, Oct. 25, 1927. Method of producing brick and tile, characterized by the fact that a suitable clay is heated, for expelling the hydrate water and dissociating the clay substance, to a temperature of 300°C at the lowest and 900°C at most, depending on the nature of the clay, however, not more than that a certain amount of the plastic clay substance remains for binding the matter, which is then crushed and moistened with water and pressed to raw brick and tile which may then be fired without any previous drying.

Refractories

Progress report on investigation of sagger clays: their elasticity, transverse strength, and plastic flow at 1000°C. IV. R. A. HEINDL. *Jour. Amer. Ceram. Soc.*, **10** [12], 995–1004 (1927).—This is a 4th Progress Report outlining results and data which are supplementary to results published in the 3rd Report. This Report contains values of modulus of elasticity, transverse breaking strength, and maximum fiber elongation of 17 representative sagger clays as determined by tests at 1000°C and includes (for comparative purposes) the values of these same properties previously determined at several lower temperatures. At 1000°C the rigidity of the clays has greatly decreased and the cross-breaking strength has greatly increased when compared with values obtained at room temperatures. The pyrometric cone equivalent (P. C. E.) value of

the clays appears to give the best indication of the relative plastic deflection exhibited at 1000°C.

The use of silicon-carbide refractories in boiler furnaces. B. M. JOHNSON AND J. A. KING. *Jour. Amer. Ceram. Soc.*, **10** [12], 1007–15 (1927).—The chief causes of failure of refractories in boiler furnaces are slag adhesion, erosion, and failure of structure, dependent on the type of coals and feeds used. Some of the physical and chemical properties of different types of refractories are given. The development of bonded silicon-carbide brick is mentioned. Clinker trouble is eliminated by use of these brick in furnaces using all kinds of present-day stoker equipment. Failures due to chemical reaction between iron and silicon carbide, and torch action on a wall produced by a blast of flame under pressure together with medium amounts of iron in the ash are discussed. Air cooling of walls is taken up. Installations of air-cooled silicon-carbide blocks are listed and discussed. Water cooling, the use of preheated air, and conditions of use of the water wall are taken up.

The significance of the elasticity and thermal expansion of fire clays with reference to the spalling of the fired product. R. F. GELLER. Amer. Refrac. Inst., *Tech. Paper*, No. 4, Oct., 1927.—This is the 1st Progress Report. The thermal expansion (below 200°) and absorption values of the reheated brick bear a sufficiently close relation to their resistance in the spalling test to indicate that they are very important factors. Of the 9 brands discussed in detail those which withstood 10 or more quenchings showed an average expansion (at 200°) of 0.12% and an absorption between 6 and 11%, and those which withstood less than 10 quenchings showed an average expansion (at 200°) of 2.4% and an absorption either less than 6 or more than 11%. While the information at hand is limited, it warrants the statement that the differential thermal expansion between a grog and a clay (or clays) in the batch, or between the clays of a batch, may exceed the amount of deformation which the grog and the clays can undergo, and that such a condition of interstructural stress may be sufficient to seriously impair the strength or to cause rupture. Since the qualities of the clays used in manufacturing a brick may be sufficiently different to cause serious interstructural stresses, or to further change in the brick after prolonged heating (such as the formation of glass) which would cause the expansion behavior of the heated end to be different than the cooler portions, and since the qualities of the individual clays are averaged (and often masked) in the brick, it is important that the qualities of each raw material be determined.

PROPERTIES OF CLAYS

		Modulus of rupture (R) lbs./sq. in. (cold	550°)	Modulus of elasticity (E) lbs./sq. in. (cold	550°)	Maximum elongation R/E (cold	550°)	Linear thermal expansion (550°)
				(*a*)	(*a*)	%	%	%
North Mo. semiflint	*A*	3000	2100	68	63	.04	.03	.48
	B	3000	3000	57	59	.05	.05	.46
Pa. semiflint	*A*	1200	1500	36	41	.03	.04	.25
	B	650	650	14	16	.05	.04	.22
Pa. flint	*A*	200		3		.07		.39
	B	120	130	3	4	.04	.03	
Ky. semiflint	*A*	980	1600	23	32	.04	.05	.39
	B	560	710	11	14	.05	.05	.37

A = clay fired to cone 12
B = 50% clay and 50% grog (of same clay) fired to cone 15
(*a*) All values to be multiplied by 10^5

In addition to the above, the following information is given for a number of brands of brick and a number of fire clays: (1) petrographic examination of the raw clays;

(2) linear thermal expansion of some of the principal refractory clays; (3) results of 3 series of quenching tests on fire brick; (4) curves showing the effect of absorption on the linear thermal expansion of 2 semiflint clays. F.P.H.

The significance of the silica transformations in the firing process and the behavior of refractory brick in use. E. STEINHOFF. *Gas Wasserfach*, **70** [11], 237–40; [12], 264–68 (1927); *Stahl und Eisen*, **47** [30], 1256 (1927). F.P.H.

The use of old refractory brick in making mortars for boiler furnace refractories. J. A. FAULKNER. *Iron Steel Eng.*, **3** [5], 218–20 (1927); *Stahl und Eisen*, **47** [30], 1256 (1927). F.P.H.

Newer viewpoints on the application of refractory materials in the metals industries. K. ENDELL. *Metall. Erz*, **24** [10], 225–30 (1927); *Stahl und Eisen*, **47** [30], 1256 (1927). F.P.H.

Quarrying bauxite in Arkansas. ANON. *Rock Prod.*, **30** [21], 49–52 (1927).—Bauxite borders between metallic ores and rock products. It is the principal ore of aluminum and yet a great part of the world's production is converted into abrasives, chemicals, and, in late years, cement. The article contains a description of the mines and plant of the American Bauxite Co. F.P.H.

On the masonry (walling up) of magnesite brick. K. ENDELL. *Stahl und Eisen*, **47** [22], 923 (1927). F.P.H

Causes of ring formation in the sintering zone of rotary kilns. KARL BIEHL. *Zement*, 817–20 (1927); *Rock Prod.*, **30** [22], 102 (1927).—B. groups the causes as follows: (1) raw materials, (2) fuel, (3) kiln, (4) lining. Samples designated as *A*, *B*, and *C*, of rings were obtained from 3 different plants. These differed greatly in shape, color, and structure. (1) *A* showed a considerable increase of the iron, alumina, and silica contents with a strong decrease of the lime content; a certain increase of the SO_3 content was also noted. The cause of ring formation in this case is undoubtedly due to the admixture of the coal ash to the cement and the subsequent increase of fluxing materials. (2) *B* shows a marked decrease of silica, iron, alumina, and lime with a very pronounced increase in SO_3 group. Evidently the cause here differs from that for sample *A*. The presence of alkali sulphates determines the ring formation in this case. (3) *C* similar to *A* shows increased contents of iron, alumina, and silica and a decrease of lime. The SO_3 content is higher, but seems to be but of minor importance in determining the ring formation. Quite obviously the materials used in this case are responsible for the latter. The following conclusions may be drawn with regard to obviating the undesirable ring formation: (1) The materials should be ground to sufficient fineness and should be uniform throughout and their chemical composition should be within definite limits; (2) the silica modulus should be kept within certain limits; (3) fluxing materials such as iron, alumina, sulphates, and alkalis should not exceed ½ of the silica content, in accordance with practical evidence; mix with relatively low-lime content; sinter and fuse more readily; (4) the materials should be changed continuously and uniformly; (5) the fuel should be of even quality and have the same properties; pulverizing coal for rotary kilns is of utmost importance, as otherwise the ash separates from the air currents in the sintering zone and settles along the walls of the kiln. Coal with low sulphur content is of great advantage when the mix contains relatively high alkali quantities. Low ash percentage of the coal invariably reduces the formation of rings; (6) the acid or alkaline character of the ash is also of importance, as it may influence the fusibility of the clinker; good draft is a most important factor. F.P.H.

On the deformation test of refractory materials. HERMAN SALMANG. *Sprechsaal*, **60** [27], 477 (1927).—A description of an apparatus used successfully for 2 years for testing the deformation of refractories. The aims of the apparatus are to apply pressure vertically and keep the load constant throughout the test. The apparatus consists

essentially of a furnace, a vertical plunger carrying weights by means of which the load is applied to the specimen; a double planchette containing holes for an adjustable rod attached to a lever which greatly magnifies and records the amount of deformation of the brick or refractory being tested. R.A.H.

The destruction of refractories by gases and the accompanying flue dust; possibility of the elimination of these harmful influences. W. BRASS. *Sprechsaal*, **60** [31], 553–55 (1927).—Discussion of previous work done with the following conclusions: (1) the fire brick are destroyed by the gas stream as well as by the flue dust; (2) in gas firing the use of purified gas is unconditionally recommended; (3) when it is impossible to have clean gases as with pulverized coal firing, it is advisable to make use of a proper protective coating on the fire brick. R.A.H.

Contribution to the investigation of deformation under load. OTTO BARTSCH. *Sprechsaal*, **60** [32], 571–73; [33], 592–95 (1927).—A discussion on the apparatus of Hirsch-Hecht and Steger for the determination of deformation under load at high temperatures and the shortcomings of this apparatus. The description of an improved apparatus is given which overcomes these defects. R.A.H.

Refractory Materials Section, Ceramic Society. ANON. *Pottery Gaz.*, **52** [605] 1759–67 (1927).—The annual meeting was held at Bournemouth, on Sept. 26 and 27, 1927. In "A Consideration of Steel Works Refractories," A. T. Green shows the importance of a dry, well-lighted, and convenient storage place for refractories. The paper on "Silica Brick," by W. J. Rees and W. Hugill, describes a series of investigations undertaken with the object of ascertaining the effect on the properties of silica brick of the specific-bonding material employed. It is pointed out that it has been generally understood that the added bonding material, such as lime, not only gives the necessary mechanical strength to the green and fired bricks, but also increases the rate of inversion of the quartz by its action in producing, at kiln temperatures, a melt in which silica will dissolve. It was found, however, that with a suitable grading of the silica rock it is possible, by the ordinary hand-molding methods, to make brick of normal commercial size which are strong enough to permit handling in the green state, and are of fair mechanical strength when fired. Silica brick are made up from quartzite rock by ordinary hand-molding methods without any added bonding material whatsoever. The properties of brick which are fired in an ordinary round, downdraft, commercial kiln, are compared with lime-bonded silica brick of the same grading, fired alongside them. It was ascertained that the degree of quartz conversion is greater in the brick without the added bond than in the lime-bonded brick, though in the former the inversion is almost entirely to cristobalite, while in the latter tridymite has been formed in fair proportion. The results indicate that the addition of a melt-forming bond does not accelerate the rate of quartz inversion, but that it does promote the formation of tridymite. "The Drying of Clays," by R. F. Troop and F. Wheeler, outlined the results of a number of experiments in connection with the drying of clays. An endeavor was made to study (1) contraction and the influence of the rate of drying upon the shape of the piece, and (2) the effect of the physical conditions of the drying medium on the rate of the removal of the moisture from the clay, and upon the distribution of moisture in the shape. The conclusion is that methods of working have an undoubted effect upon the contraction and distortion of clay bodies, and that where distortion is experienced in manufacture it is worthy of consideration as to whether some modification of the particular way in which the shape is built up is not called for. A paper by W. C. Hancock and J. G. Gowan deals with the crushing strength of unfired fireclay bodies. Experiments made with the object of obtaining some measure of the crushing strength of unfired clay bodies and comparing these with the tensile strength are described. The results show that the shape or the relative dimensions of the test

pieces have an important influence. In "The Characterization of Clay," F. H. Brooke emphasizes the necessity, in the examination of a clay, of paying particular attention to a determination of the proportion of the fractions of the different-size particles, and of studying in detail the finest ones. It has, in the past, been commonly assumed that clays contain a small proportion of extremely fine material, to which their characteristic properties are due, high and low plasticity being associated with a larger or smaller proportion of these substances. But this can no longer be held to be the case, as it has been definitely ascertained that all plastic clays, and some of comparatively low plasticity, can be obtained in the form of very fine material. Much remains to be done in the way of subdividing the fraction of clay into finer fractions, but it is almost certain that the 0.002 mm. fraction of a plastic material consists of particles sufficiently fine if they are broken down, to be considered "colloidal," and that the colloidal content of a raw material might be taken as identical with its "clay" content. In "The Effects of Temperature on the Mechanical Properties of Silica Products," A. J. Dale describes in detail the tests undertaken at the instance of the British Refractories Research Association, supported by the Institution of Gas Engineers, to prove to what extent the load test may be utilized both by the manufacturer and the user to determine the suitability of silica brick for various purposes. E.J.V.

Water-cooled furnaces in 1921. ANON. *Combustion*, **17** [4], 233 (1927).—Two photographs of water-cooled furnaces in India installed by W. F. Goodrich are reproduced. G.W.W.

Silica bricks for steel foundries. A. H. MIDDLETON AND C. BRIDE. *Foundry Trade Jour.*, **36** [578], 242 (1927).—The requirements for an ideal refractory are high refractoriness, great mechanical strength at all temperatures, resistance to spalling on sudden heating, antislagging properties, resistance to abrasion by furnace gases, and a minimum thermal expansion. A good silica brick represents a useful compromise of these qualities. The chemical composition has the least effect on the behavior of a refractory in use which depends on the composition of the raw stone and the amount of added fluxes. The composition determines the melting point. An increase in silica causes an increase, while iron alumina, magnesium, calcium, and the alkalis lower the melting point. If the silica content is greater than 95% the effect of varying the composition on the melting point is small. The refractoriness of a silica refractory is the temperature at which the material loses its shape. The matrix melts first and combining slags and dusts can form low melting compounds. The cold-crushing strength of various silica materials varies from 1000–5000 lbs. per sq. in. Fluxes increase the strength but lower the melting point. The silica conversion effects spalling; the cristobalite change at 220°C is the most serious; the quartz and tridymite change is small. Underfired material shows desirable nonspalling properties at low temperatures and can be used where sudden heating is unavoidable, but well-fired material is to be preferred for most purposes. A porosity of 28–30% and the size of pores will cause variation in spalling tendencies in equally converted silica materials. If a maximum resistance to spalling and corrosion by molten slags and hot-furnace dusts is required in well-converted material it is wise to choose that with the greatest tridymite growth. According to Scott, corrosion by molten slag consists in solution of the refractory material in the slag. A high concentration of free silica in the matrix forms a viscous glaze providing a protective coating against further attack. The most resistant structure seems to be that developed by producing a medium-grained texture, giving sufficient firing in the kiln, to produce the strongest possible tridymite growth in the matrix. This procedure produces a hard structure and reduces porosity. Corrosion is less when the inner surface of a furnace is smooth. True, clean, accurate-size shapes are essential. Exposed joints should be reduced to a minimum. To obtain accurate sizes and shapes requires the best

methods of molding and kiln firing control. Well-converted material is more uniform in size. G.W.W.

Notes on oil firing. R. L. TULLIS. *Power*, **66** [1], 20 (1927).—This article discusses problems of oil firing including leaky valves, water in the oil, wet atomizing steam, poor piping. The proper temperature for the oil heater is 160°F. Strainers must be fine-meshed, easily and often cleaned. Globe and needle valves are not satisfactory because they are easily clogged and hard to regulate. Special V-shaped oil-firing valves should be used. G.W.W.

The effect of water-cooled walls on furnace operation. W. J. WOHLENBERG AND F. W. BROOKS. *Power*, **66** [1], 35 (1927).—In discussing the influence of water-cooled walls, W. and B. use the term "fraction-cold" to represent the ratio of the projected water wall area to the total wall area in the furnace. The particular advantage gained by the use of water-cooled walls is that if the fraction-cold is increased from 0.2 to unity, the permissible rate of energy release for a given flame may be more than doubled. A water-cooled furnace should not be operated at low temperatures. Little thermal advantage is obtained from refractory-covered water-cooled walls when the refractory thickness becomes greater than 2 inches. G.W.W.

Service factors governing slagging of boiler furnace refractories. R. A. SHERMAN AND E. TAYLOR. *Power*, **66** [3], 112–13 (1927).—For abstract see *Ceram. Abs.*, **6** [9], 383 (1927). G.W.W.

Properties of refractories in zinc metallurgy. E. S. WHEELER, A. H. KUECHLER, AND H. M. LAWRENCE. Missouri School of Min. and Met., *Bull.*, **10,** 2 (1927).—The frequent renewals of retorts and condensers and the occasional repairing and rebuilding that a furnace requires in the metallurgy of zinc warrant careful consideration of the raw materials, clay and grog, that are used for the manufacture of the refractory shapes. The investigation covers raw materials and body mixtures now in use, the comparative values of various grog materials and clays and the effect of reclaimed retort materials and zinc oxide upon the physical properties of retort mixtures. There are detailed discussions of the results obtained by the authors under each subject.

The behavior of clay refractories in service. R. F. GELLER. *Fuels and Fur.*, **5** [9], 1189–92 (1927).—Brick that has been subjected to severe temperatures for a week may have very little resemblance, in its fundamental characteristics, to the brick as drawn from the kiln. A particularly significant change is that of the spalling properties of a brick which has been used in a wall with only one face exposed to the heat. To illustrate the effect of differential dilatation G. describes an experiment in which 2 bars of brick having different thermal expansions are cemented at the ends by means of thin plates of glass at 1050°C and are then allowed to cool. A differential thermal dilatation of 0.15 to 0.20% is sufficient to cause rupture. G. shows thermal-expansion curves for one type of aluminous brick and 2 types of siliceous brick (1) as received, (2) after 1400°C reheat, and (3) after 1500°C reheat. The thermal expansions of these types and the changes they undergo when reheated are correlated with their behavior in the quenching test. It is shown that the action of heat alone on the exposed face of a brick in a wall may produce a condition conducive to spalling with some types of brick and not with others. A.E.R.W.

Refractory linings for forge and heating furnaces. M. C. BOOZE. *Fuels and Fur.*, **5** [9], 1197–98 (1927).—Furnaces used for heating forgings and metal shapes are operated under widely varying conditions so that no specifications on refractory lining materials can be universally applied. B. describes some of the very severe conditions that may obtain. The best selection of materials to meet the conditions in a particular furnace can only be determined by repeated trials, although a knowledge of the properties of the available materials should reduce the necessary tests to a minimum. The operator

must frequently resort to the use of 2 or more refractories in the same furnace in order to prolong the lining. Properties and the conditions of the uses of fireclay brick and diaspor, sillimanite, chrome, and plastic refractories are described. In using refractories, thick joints, flame impingement, and the accumulation and freezing of liquid slag should be avoided. A.E.R.W.

Electric melting furnaces used in making steel for bearings. ANON. *Fuels and Fur.*, **5** [11], 1459–62 (1927).—A description of an installation of 3 arc-melting furnaces at the plant of the Timken Roller Bearing Co., Canton, Ohio. The furnaces are equipped with a basic lining, that of the hearth being in 3 layers, the first of crushed magnesite, the next of magnesite brick, and the lower or supporting lining of fire brick. The roof and walls are lined with silica brick to a depth of 13 in. A.E.R.W.

Heat-insulation. J. S. F. GARD. *Jour. Soc. Chem. Ind.*, **46 T,** 101–105 (1927).—For abstract see *Ceram. Abs.*, **6** [3], 105 (1927). H.H.S.

The effect of reclaimed retort material and zinc oxide on the physical properties of retort mixtures. E. S. WHEELER. *Bull. Amer. Zinc Inst.*, **10** [5–6], 97–107 (1927).—A number of body mixtures for retorts were subjected to 9 standard tests. Besides the standard mix, which consisted of 50% fire clay and 50% flint clay, the mixes were made to contain increasing porportions of old retort material and in some cases ZnO. The addition of old retort material produces a lowering of the deformation value of a mixture whereas the addition of ZnO seems to have little effect. Values for the water of plasticity and drying shrinkage were obtained. The mixtures containing ZnO up to 7.5% showed the lowest drying shrinkage. A mixture of 50% fire clay and 50% old retort material showed the highest shrinkage. A graph of the porosity of the mixtures at various temperatures showed the standard mix to have a uniform and low porosity. Absorption values follow the trend of the porosity values almost exactly. Volume change on firing and transverse-strength measurements brought out the important fact that ZnO weakens the mixtures considerably at all temperatures. Mixtures containing ZnO also make the poorest showing when subjected to the sag test. Those containing over 25% old retort material show up poorest under the spalling test. The chemical analysis of each of the mixes is included. (*C. A.*)

Silica bricks for steel works. A. H. MIDDLETON AND C. BRIDE. *Jour. West Scot. Iron Steel Inst.* **34,** 64–75 (1927).—A general discussion is given of the manufacture of SiO_2 brick with the effect of composition, grain size, and firing on the nature of the refractory. The transformations during firing are given in detail, with photomicrographs. The conditions met by SiO_2 refractories in the steel industry are reviewed. (*C. A.*)

Load and thermal expansion tests on silica brick. H. HIRSCH. *Tonind. Ztg.*, **51,** 759–64 (1927). (*C. A.*)

Apparatus for the determination of thermal conductivities of high-temperature insulation. R. H. HEILMAN. *Trans. Amer. Inst. Chem. Eng.*, **18,** 283–93 (1926).—Data are given of an investigation on the development of a flat plate testing device for the accurate determination of the thermal conductivities of high-temperature insulation and refractory materials. The conductivity of a flat plate is expressed by $K = [W \times 3.415 \times \text{thickness (in.)}]/\text{area } (t_1 - t_2)$. (*C. A.*)

BOOK

Graphite. E. RYSCHKEWITSCH. xii+323 pp. Leipzig: S. Hirzel, 1926. Price 16.50M.—Reviewed commendingly in *Chem. and Ind.*, 274 (1927). Deals with graphite as heat-resisting material, as conductor of electricity, as pigment, lubricant, etc., and with the chemistry, physics, mineralogy, winning, and refining of natural graphite, and with the Acheson and other processes for artificial graphite. See *Ceram. Abs.*, **6** [9], 389 (1927). H.H.S.

PATENTS

Method of forming refractory crucibles. HOWARD T. REEVE. U. S. 1,648,149, Nov. 8, 1927. The method of forming a refractory crucible which comprises applying a plurality of layers of highly refractory material to a reducible medium surrounding a core, drying each layer by heat, removing core, and firing the crucible.

Refractory materials. SCHEIDHAUER AND GIESSING AKT.-GES. Brit. 262,383, Dec. 4, 1925. Nonplastic refractory materials such as sillimanite, cyanite, chromite, alumina, Carborundum, ZrO_2, magnesite, or dolomite are used instead of chamotte in clay-bonded products as described in Brit. 253,947. See *Ceram. Abs.*, **6** [10], 451 (1927). (*C. A.*)

Dissolving aluminiferous raw materials by means of sulphuric acid or acid sulphates. R. JACOBSSON. Brit. 269,174, April 4, 1927. Bauxite, clays, etc., as silt are supplied under pressure and at a regulated speed to an autoclave charged with sulphuric acid or an acid sulphate, or the materials are mixed outside the autoclave and the mixture is supplied to the vessel at a regulated speed. The reaction temperature is 185° and the products are continuously or intermittently drawn off, fresh raw material being added at the same time. The solution of aluminium sulphate is separated from precipitated silica at a temperature of at least 120°. (*B. C. A.*)

Refractory articles. UNITED STATES METALS REFINING CO. Brit. 276,016, Oct. 5, 1927. In the manufacture of refractory articles by molding a mixture of dead-burned magnesite and a siccative oil, the oil is allowed to become oxidized by heating or standing to enhance its binding properties. If raw linseed oil is used, it may be heated either before or after mixing with the body material but before molding. Alternatively the plastic mass of magnesite and oil may be allowed to stand for some time before molding. The molded articles are preferably dried slowly under conditions of increasing temperature and decreasing humidity. Finally, the articles may either be fired before use or built into a furnace and fired *in situ*. To obtain a compact product the magnesite is preferably composed of a mixture of different degrees of fineness, and the molding is performed under pressure. Any vegetable or animal siccative oil may be used; driers such as oxides of lead, manganese, or cobalt, and thinners such as light mineral oils may also be added. The best proportion of oil is about 6.5% of the magnesite.

Refractory substances, abrasive compositions. E. C. MARKS. Brit. 276,185, Oct. 12, 1927. A refractory material particularly suitable for lining furnaces, but also suitable for other purposes such as the manufacture of grind-stones, etc., is obtained by baking a mixture of aluminous cement and corundum.

Magnesite refractory. A. MARKS. Can. 272,533, July 19, 1927. Molded magnesite refractories are manufactured by mixing with the pulverized magnesitic refractory body material a suitable siccative oil to form a plastic mass, the article then being molded and dried to hardness. (*C. A.*)

Production of articles containing silicon carbide. GEBR. SIEMENS AND CO. Ger. 438,065, May 13, 1924. A plastic mass containing tragacanth, alone or mixed with water-glass, and powdered silicon carbide, with or without the addition of other material, such as mixtures of carbon with silica, silicon oxychloride, or silica, is molded into the desired shape. (*B. C. A.*)

Decomposition of aluminous material. BÜTTNER-WERKE A.-G., AND F. KLEINMANN. Ger. 439,540, Jan. 14, 1925. The unroasted material is ground wet before or during the usual decomposition with alkali hydroxides, and during the grinding and decomposition processes the material is treated with oxidizing agents which do not hinder the decomposition process and the subsequent precipitation of aluminium hydroxide, such as chlorine, chlorates, peroxides, or hypochlorites. (*B. C. A.*)

Terra Cotta

Soluble salts and their application to terra cotta. A. H. HOTTINGER. *Bull. Amer. Ceram. Soc.*, **6** [11], 341–42 (1927).—Just as it is true in the production of colored glazes and enamels that a given coloring oxide will produce various shades and colors, depending on the composition of the glaze or enamel in which it is used, so is it true that soluble salts will produce a great variety of shades and colors, depending on the composition of the mottled finish over which they are applied. In many cases where polychrome is called for, soluble salt colors are used for the following reasons: (1) the simplicity of application, due to the fact that they can be applied directly over the mottled finishes without brushing off or masking the part where the color is to be applied, (2) the harmonious results in the finished product, because the colored area has the same texture as the balance of the material and not the hard, cold surface of contrast that is so apparent in colored glazes, (3) the economy of these colorants is another item worthy of consideration. A table is given showing colors obtainable with various salts. The resultant color varies according to the enamel slip or glaze over which the salt is applied. E.J.V.

Hairlining and peeling in engobes and glazes. ANON. *Ceram. Ind.*, **9** [5], 562 (1927).—The prevention of hairlines or peeling of engobes can be accomplished by the choice of the proper clay and watching the consistency of the engobes. When it becomes necessary to thin an engobe, quartz is a good medium to employ, and the addition of a small quantity of whiting is also recommended. In glazes for covering engobes the use of too much soda ash and boric acid is often the cause of hairlines and peeling. An engobe will often insist on peeling even though a small quantity of whiting is added from time to time; when this occurs it is said that a complete rearrangement should be made of the engobe so that it will contain between 25 and 30% whiting. Formulas are given for glazes and engobes. F.P.H.

Stoneware exhaust fans and blowers. P. C. KINGSBURY AND F. E. MEHRHOF. *Trans. Amer. Chem. Eng.*, **18,** 103–29 (1926).—Experiments were conducted on 4 stoneware exhausters. A brief review of the development of a satisfactory stoneware exhauster is given. Data and the method of calculating results are tabulated and graphed. (*C. A.*)

White Ware

The effect of potash and soda feldspars in china body. EDWARD SCHRAMM. *Jour. Amer. Ceram. Soc.*, **10** [12], 1005–1006 (1927).—Discussion of "Bureau of Standards Investigation of Feldspar, 2nd Progress Report," by R. F. Geller. See *Jour. Amer. Ceram. Soc.*, **10** [6], 411–34 (1927) and *Ceram. Abs.*, **6** [7], 291 (1927).

Physical properties of semivitreous bodies. ANON. Bur. Stand., *Tech. News Bull.*, No. 126, pp. 7–8 (1927).—An abstract of a report published as a limited edition by the U. S. Potters Assn. on an investigation of the physical properties of semivitreous white ware for domestic table use. The report, largely nontechnical in character, contains a résumé of the data obtained by physical tests of representative commercial bodies, bisque fired and glazed in various ways, and also a discussion of the petrographic study of several of the bodies. This discussion is illustrated by reproductions of photomicrographs. The more important conclusions were that, (1) American earthenware bodies differ more than is generally realized in regard to their maturing temperature. Some mature fully at cone 7, others at cone 9; (2) there are 2 periods of firing during which the absorption of the body is materially decreased, one between cones 4 and 5 (because of the presence of English ball clay) and one between cones 6 and 8 (because of feldspar); (3) desired maturity of a body can be obtained by firing at a lower temperature (*e.g.*, cone 6) and then holding at this temperature until cone 8 is down. Soak-

ing at cone 4 lowers the absorption at an average rate of 0.97% per hour, soaking at cone 6 lowers the absorption 1% per hour, and at cone 8 about 1.47% per hour; (4) glazed bodies usually are stronger mechanically than they are before glazing but this presupposes a good glaze fit; (5) in well-fired semivitreous bodies the fusion of the feldspar is complete, there is some surface attack of the feldspar on the flint particles and the local formation of fine crystals of mullite; (6) a well-fired glaze will show considerable attack upon the surface of the body, resulting in the growth of mullite needles into the glaze at right angles to the body surface. R.A.H.

The putty problem in the construction of insulators. KARL WAGNER. *Sprechsaal*, **60** [34], 611–12 (1927).—A discussion on porcelain insulator putties, what is required of them, and the necessity of controlling them. R.A.H.

Defects in slip-banded ware. ANON. *Ceram. Ind.*, **9** [5], 564–68 (1927).—Defects often met with in the teapot trades, and also to some extent, but less frequently, in the case of slip banded earthen ware, usually termed "dipped ware" are discussed. Peeling exhibits itself in the form of a peeling off of the band. The peeling might occur (1) prior to the biscuit firing, (2) during the biscuit firing, and (3) during the glost firing. It is suggested that the primary cause of the fault is the differential contraction between the body and the slip, created during either drying or firing, while lack of mechanical adhesion or bond between the two is a contributing factor. The possibility of scumming in this connection must not be overlooked. Underglaze colors containing a high proportion of highly refractory inerts, such as alumina or whiting, are more subject to peeling than the more heavily fluxed colors. There can be little doubt that a badly designed or incorrectly worked drying-room is productive of loss. The quantity of peeling which develops during the glost firing is small, although it is true that incipient peeling might be emphasized by the use of incorrect glazes. Glazes possessing a high elasticity and fluidity are desirable. Because of this fact, troubles have arisen from time to time when leadless glazes have replaced the older types of lead glazes. F.P.H.

Demand for German porcelain weakens. ANON. *Ceram. Ind.*, **9** [5], 572 (1927).—Germany has long been one of the world's largest producers of porcelain for both household and industrial use. The fact that only 66–75% of the capacity of the industry is being utilized at present has given rise to considerable discussion as to the best means of ameliorating conditions. Suggestions as to the most practical solution range from coöperative advertising and standardization of patterns and grades to the formation of a trust and price-fixing cartel; the latter has been the favorite method employed by most German industries to cure their ills. F.P.H.

Checking up costs on sanitary ware, VI. E. J. BORTON. *Ceram. Ind.*, **9** [5], 574–78 (1927).—B. discusses the finding of costs in the sanitary ware industry exclusively. F.P.H.

The production situation of the whiteware industry in the U.S. ANON. *Keramos*, **6** [8], 287–88 (1927). F.P.H.

The historical development of the Ilmenauer Porcelain Works. ANON. *Keramos*, **6** [8], 302–303 (1927).—An historical sketch is given of the Ilmenauer Porcelain Works which celebrated its 150th anniversary on July 18, 1927. F.P.H.

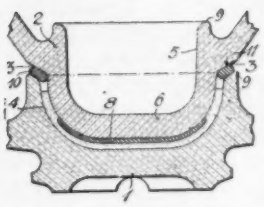
Spark-plug insulation. ARTHUR S. WATTS. *Ind. Eng. Chem.*, **19** [10], 1123–24 (1927).—A review of the development of the present-day spark plug. The present practice seems to be to use a mixture of artificial magnesium-aluminum silicate, clay, and artificial mullite for the spark plug body and this is best fired in a tunnel kiln. The continuous tunnel kiln eliminates the difficulty of variable firing treatment. Some of the requirements of a spark plug are listed as also are the considerations necessary in designing a porcelain body for a spark plug. R.J.P.

Homer Laughlin's new plant at Newell, W. Va., opens; increases capacity to 125 kilns. ANON. *Pottery, Glass, and Brass Salesman.*, **36** [12], 27 (1927).—Plant No. 7, the new $1,250,000 plant equipped with Harrop bisque and glost kilns and a Holcroft automatic decorating kiln was placed in operation, Oct. 24, 1927. Its capacity is about 20 old-style upright kilns and brings the total capacity of the Company's plants to about 125 kilns. E.J.V.

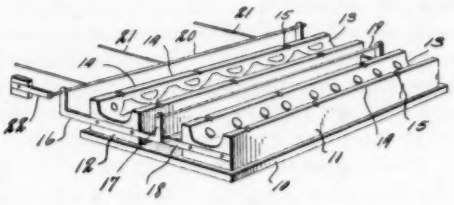
The effect of the addition of sodium carbonate and sodium silicate on the casting properties of clay slip. F. E. BROWN AND CHI-FANG LAI. *Proc. Iowa Acad. Sci.*, **33**, 170 (1926).—(An abstract.) The addition of small amounts of Na_2CO_3, or of Na_2SiO_3 increases the plasticity of some clay slips and permits them to be cast when they contain a much smaller percentage of H_2O. This permits much faster casting. Casts are made and removed from the mold in 20 min. The time for a cast increases for successive casts as the mold becomes filled with H_2O. After drying the original rate is possible. A mixture of Na_2CO_3 and Na_2SiO_3 is found to be superior to either alone. The use of these salts does not injure either the mold or the quality of the pieces cast. As many as 100 pieces are cast in one mold. (*C. A.*)

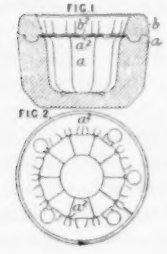
PATENTS

Method of assembling insulators. KENT ALLEN HAWLEY. U. S. 1,647,695, Nov. 1, 1927. The method of connecting insulator parts adjoining ones of which are formed respectively with a recess and projection, comprising applying adhesive material to the projection of one element to extend over the end and about a portion of the side thereof, applying compressible waterproof adhesive material to the edge of one part at the area where it is to contact with the adjacent part, assembling the parts in nested relation, and applying axial pressure whereby the adhesive material will unite and temporarily connect the parts.



Die and ejector for making clay-heating elements. WILLIAM B. LOUTHAN. U. S. 1,648,649, Nov. 8, 1927. Means for making clay-heating elements comprising two female dies disposed in parallel relation, one of the dies being hinged to the other whereby one may be turned over into or out of confronting relation to the other, both having their side walls formed with aligning notches, a shaft extending parallel to the dies and having radially extending fingers adapted to be disposed in notches and across the 2 dies when they are disposed in confronting relation, and male dies adapted to co-act with the female dies to initially produce 2 halves of the completed element.





Pottery molds. C. F. BAILEY. Brit. 275,067, Sept. 21, 1927. The plaster mold for casting or jolleying cups, dishes, etc. is formed in 2 horizontally-divided parts, the meeting edges of which are shaped to impart a scalloped edge or rim to the article. In the illustrated form the parts (a^2, b^2) of the mold sections (a, b) form a scalloped rim to a cup.

Equipment and Apparatus

A suggested new base point on the thermometric scale and the $\alpha \rightleftarrows \beta$ inversion of quartz. F. BATES AND F. P. PHELPS. Bur. Stand., *Sci. Paper*, No. 557 (1927).—

A careful investigation of the so-called heating and cooling curves for crystalline quartz has been carried out. Temperature measurements were made by means of thermocouples inserted in small holes drilled in a crystalline plate. By holding the temperature of the furnace when passing through the inversion point as nearly constant as possible, considerable new experimental data bearing on the nature of the inversion were obtained. Superheating and supercooling accompany the transition. The temperature at which the inversion begins on both heating and cooling, as well as the true transition temperature, have been determined. From the characteristics of the curves it has been found possible to calculate the heat of transition at the inversion temperature. Specimens of quartz from sources widely distributed geographically were studied and the temperature at which the inversion starts on heating was found to be identical. This temperature occurring with great sharpness is suitable for a new type of base point on the thermometric scale, as well as for the standardization and checking of thermocouples in the average physical laboratory. R.A.H.

Improvements in ceramic machinery. W. DEMUTH. *Sprechsaal*, **60** [29], 513–14 (1927).—A composition called "Turbax" is used in manufacture of gears to eliminate source of iron in porcelain bodies and shows a Brinell hardness of 39 against 12 for fiber and 8 for rawhide, both of which are used at present and can be displaced to advantage with turbax. R.A.H.

Some considerations and observations on the mode of operation of the shaker sieve. A. H. M. ANDREASEN. *Sprechsaal*, **60** [29], 515–17; [30], 531–33 (1927).—In making a sieve analysis with a specified time-limit the effective distribution and quantity of material on the sieve as well as the per cent of clogged meshes must be considered. A. gives a mathematical analysis of these factors. R.A.H.

Soft rubber filter-press plates and frames. H. E. FRITZ AND J. H. CLARK, JR. *Ind. Eng. Chem.*, **19** [10], 1151 (1927).—A discussion of the use of rubber filter-press plates and frames to meet the need for a corrosion resistant material. A table gives a list of chemicals and conditions under which rubber is successfully used. R.J.P.

Belt conveyers. ANON. *Eng. News Rec.*, **99** [15], 614 (1927).—A new design of belt conveyer carrier is described. It is made by the Stephens-Adams Mfg. Co. It consists of 3 rollers in line, the troughing rollers being mounted at a 20° angle. The belt carriers will be made in widths ranging from 12 in. up to 60 in. The carriers are mounted on a heavy steel angle section base and the whole assembly tilted slightly in the direction of belt travel to facilitate the proper training of the belt. The rollers are of steel tubing, with drawn steel end plates. Each roller is equipped with 2 Timken roller bearings, with permanent bearing adjustment provided by lock screws. The lubrication of the rollers is obtained by the use of 2 high-pressure grease fittings in each shaft. P.F.C.

Dust collection: the story of the recently-developed Sirocco collector. J. C. POLK. *Combustion*, **17** [4], 240 (1927).—A brief review of the subject of dust collection. The several forms are: (1) the settling chamber, probably the oldest form and effective but cumbersome, occupies too much space, and is costly to install and maintain; (2) centrifugal force; (3) filtering, generally taking the form of bags; (4) the electrical method known as the Cottrell Electrical Precipitator is very effective on extremely fine dusts, but because of its high cost and the sensitive character of the equipment practical only where the dust reclaimed has great value; (5) the Sirocco collector as finally adopted consists of a volute or scroll-shaped upper chamber terminating at its smallest radius with the larger diameter of the conical casing located immediately below. The Sirocco collector's greatest use is in the collection of cinders and fly-ash suspended in the waste gases and the coal dust arising from the preparation of pulverized coal. G.W.W.

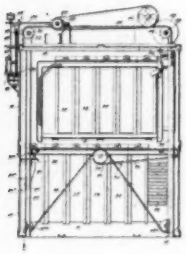
Rubber as a material for lining ball mills and for joints of pipe bends. ANON. *Mech. Eng.*, **49** [11], 1235–36 (1927).—Rubber is employed to line ball mills. Grinding takes place mainly between the balls and not between the balls and lining. By using a suitably prepared rubber, the balls tend to imbed themselves in the rubber and are thus carried farther up the sides of the drum than in metal-lined mills, thus increasing the effective grinding area. Rubber linings being lighter require less power to set the mills in motion, and there is less wear and tear on the rollers and gearing and the rubber lining lasts longer than one of hard steel, saving time spent in relining. The difficulty of anchoring in place is overcome by vulcanizing a steel channel piece in the rubber which is bolted to the shell. The rubber linings are in a number of sections with a layer of soft rubber in contact with the balls and a hard or semihard rubber vulcanized to the soft to form a bed for the outer steel rim. The internal surface has a wavelike contour. Mill speeds may be reduced 10–15% with a saving of power and no loss of output.

G.W.W.

Characteristics and operating requirements of positive pressure rotary blowers. GORDON FOX. *Fuels and Fur.*, **5** [11], 1481–84 (1927).—A discussion of the various types of rotary blowers; their characteristics, power required, and motor drive.

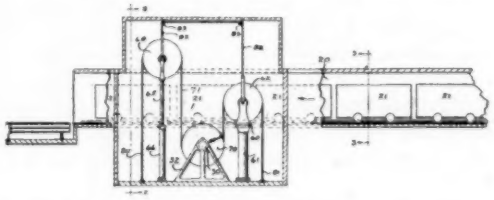
A.E.R.W.

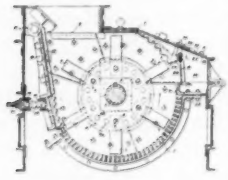
PATENTS



Drier. JOSEPH ROBERTS. U. S. 1,646,259, Oct. 18, 1927. A drier comprising, in combination, a pair of drying chambers, one above the other; carriers therein for material to be dried; guides for horizontal movement of the carriers through the chamber; an endless flexible driving element guided in vertical direction at each end of the pair of chambers; carrier-engaging means on the element for shifting carriers between the chambers; and auxiliary flexible means, having a horizontally moving carrier-engaging device thereby actuated for advancing carriers horizontally in a chamber.

Mechanism for progressing cars in kilns. GEORGE W. DENISON. U. S. 1,646,901, Oct. 25, 1927. In a drying kiln of the car tunnel type, the combination of a reciprocating draw bar extending substantially the length of the tunnel, a plurality of automatically acting members mounted on the draw bar for separately attaching each car of a train of cars in the tunnel to the draw bar when the draw bar is moving in one direction, and actuating means for the draw bar for actuating the draw bar at a greater speed in one direction than in the other of its reciprocatory motion.

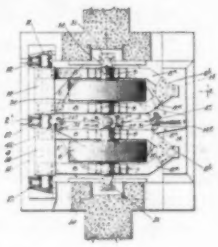




Rotary pulverizer. WILLIAM H. HARTMAN. U. S. 1,647,730, Nov. 1, 1927. In a crushing mill, the combination of rotating hammers, a cylinder in which the hammers are located, and having an inlet opening and a grinding surface having passages for the discharge of ground material, a trap external to the wall of the cylinder, a door normally shutting off communication between the cylinder and trap and arranged to open

only when a heavy object is thrown against it, and a breaker block in the cylinder adjacent to the door and arranged to deflect heavy objects against the door.

Dry-pan grinding apparatus. WILLIAM LEE HANLEY, JR. U. S. 1,648,176, Nov. 8, 1927. In a dry-pan grinding machine, the combination with a horizontal rotatable pan and mullers, of a stationary rim located slightly above the pan and providing a discharge aperture between its lower edge and the pan, the rim being formed of separate sections, having overlapping portions, and being each provided with outwardly extending brackets rigidly secured thereto, and stationary supported devices provided with screw-threaded adjusting means for engaging brackets, whereby rim sections can be independently adjusted, and held against accidental movement in any adjusted position.



Kilns, Furnaces, Fuels, and Combustion

Kilns and fuels for firing refractories. W. E. RICE. Amer. Refrac. Inst., *Bull.*, No. 15, Sept. 1927.—Of particular interest to manufacturers of refractories are the periodic kiln and the railroad car-tunnel kiln. Three general types of furnaces are used for burning coal: (*a*) dead-bottom furnace, no grates; much like a small gas producer; (*b*) sloping-grate furnace, the angle made by the grate varying from 30–60°, a modification of the dead-bottom furnace; (*c*) horizontal-grate furnace. The horizontal-grate furnace is provided with a coking plate at the front of the furnace, on which the fresh coal is coked by heat radiated from the hot arch, and a door, by which the secondary air can be controlled. Each type of furnace has certain advantages. The dead-bottom and sloping-grate furnaces are suited to low-grade coals and coals that clinker badly. The horizontal-grate furnace is best for high-grade nonclinkering coals. Tests have shown that coal is more completely burned in dead-bottom and sloping-grate furnaces; this is partly because small pieces of unburned coal fall through horizontal grates, and partly because the fires are worked more frequently on horizontal grates. However, the horizontal grate, with its bed of fuel comparatively thin and uniform in thickness, permits the passage of a greater amount of air through the fuel and hence a faster rate of combustion than the other type and more economical. The horizontal-grate furnace equipped with a door at the firing opening permits good control of rate of combustion and atmosphere in the kiln whereas the other types largely depend upon the skill of the fireman in so filling the front of the furnace with coal that the relative resistance to flow of air through the fresh coal and the main bed of fuel will supply the correct ratio of primary to secondary air; this ratio will evidently vary as the bed of fuel shrinks and increases the opening for air at the front. The rate of combustion of coal depends upon the quantity of air that passes through the bed of fuel. About one-half of the air required for combustion must pass through the bed of fuel; the remainder is admitted as secondary air over the bed of fuel. For rapid combustion the primary air must be supplied through the grates in thin streams at high velocity, therefore the use of grate bars of thin cross-section with relatively wide air spaces between is preferable to the use of wide grate bars with relatively small air spaces between. At some plants the air opening is as low as 25% of the area of the grate, whereas with narrow grate bars the air openings may easily be made 60% of the area of the grate without greater loss of

combustible in the ash and refuse. The following subjects are discussed: (1) firing with gas or oil, (2) function of bag walls, (3) setting the ware in kiln, (4) floor openings and flues, (5) chimneys and draft, (6) kiln proportions, (7) railroad car-tunnel kilns, (8) direct-fired type, (9) muffle type, and (10) types of fuels used with the various kilns. F.P.H.

The use of slack coal as a fuel for the whiteware industry. PETERS. *Ber. deut. keram. Ges.*, **8** [3], 175–88 (1927).—A description of various types of fire boxes for the use of slack coal in the firing of ceramic products. F.P.H.

British potters concentrating on "overseas" business; favor electricity for firing. ANON. *Ceram. Ind.*, **9** [5], 580 (1927).—The declining business in average quality ceramic ware with the U.S. is prompting the industry in England to concentrate still more on trade within the empire. Staffordshire potters realize that the U. S. pottery manufacturers are gradually extending their influence over their own market and are now making ceramic ware which a few years ago could only be obtained from Europe; they are gradually being squeezed from the American market. Craftsmanship in America is improving and progress continues to be made in new methods of pottery firing. Oil fuel came into use extensively during the general strike of 1926 and gas firing in continuous or recuperative furnaces has been instituted with success. The latest method of firing the ware, however, is by electricity. The electrical kiln undoubtedly will be the firing medium of the future in Staffordshire. F.P.H.

Crude-oil firing of ceramic kilns. W. BROWN. *Keramos*, **6** [8], 295–96 (1927). A discussion of the technical and economic phases of the use of crude oil for firing ceramic kilns is given. F.P.H.

From beehives to brick kilns. ANON. *Clay-Worker*, **88** [4], 261–65 (1927).—A description of the 19-kiln plant of the Jenkins Brick Co., of Montgomery, Ala. A brief history of the plant is given. The modern equipment being used is described. E.J.V.

Progress in gas producer practice. W. B. CHAPMAN. *Glass Ind.*, **8** [11], 261–63 (1927).—Producer gas is the only commercial gas used hot, raw, and unwashed. It is for this reason that it stands supreme as the most economical heating medium for ordinary furnace purposes. Modern gas producers are 90% efficient when the sensible heat of the gas is utilized, and about 80% efficient when the sensible heat is lost, as when the gas has to be conducted a long distance or washed. The net efficiency of washed gas, however, is nearer 70% because of the loss in operating the washing equipment and the additional amount of steam required in the blast. It is for this reason, together with the objectionable cost of the washing equipment, that over 90% of all producer gas installations are for hot, raw gas. Fuel oil in most cases costs 2½ times as much as coal. The possibility of pulverized coal as a cheap fuel is interesting, but not yet fully determined. This form of fuel has shown remarkable efficiencies in burning cement and lime, in boiler heating, and in many high temperature operations, but the ash content of pulverized coal has caused such serious trouble with the furnace linings and the goods to be heated that, in many cases the advantages have been largely offset by the disadvantages. These advantages and disadvantages of producer-gas fuel are enumerated and a detailed description of the development of the furnace is given. E.J.V.

Use of silica gel in drying blast. EDWIN H. LEWIS. *Fuels and Fur.*, **5** [10], 1383–84 (1927).—A description of the successful use of silica gel on a large scale for drying air for combustion in a blast furnace. A plant to treat 35,000 cu. ft. per min. has been in operation since April and has saved about 7 T. of coal per day. This idea

might be used in ceramics in drying the air used during the watersmoking period. A.E.R.W.

The composition of coal in relation to spontaneous combustion. WILFRED FRANCIS. *Fuels and Fur.*, **5** [11], 1519–20 (1927).—Abstract of paper presented at Annual Convention of the American Gas Assn., Chicago, Ill. A.E.R.W.

News of the field. ANON. *Combustion*, **17** [4], 241 (1927).—"Globar" is a Carborundum product being produced in the form of rods or bars of Carborundum, the inherent characteristics of which lend it admirably to the conducting of electrical current, which when passed through the bar produces a glowing heat up to 6200°F. It has met with great success in providing a quick, closely controlled, clean heat in heat treating and tempering furnaces, forging furnaces, annealing furnaces, in heating of glass leers, ceramic kilns, enameling furnaces, driers, etc. G.W.W.

Complete gasification of coal. R. V. KLEINSCHMIDT. *Power*, **66** [2], 70–71 (1927).—The manufacture of gas has improved along 2 lines: low temperature carbonization and complete gasification. The aim of the former is to produce a maximum of by-products, and of the latter a maximum of gas and a minimum of by-products. Both lines are of more interest in Europe than in America. The Strache generator for complete gasification and the Kreisa Gesellschaft refinement of the same process are described and shown in drawings. Single unit gasification saves heat and fuel and has flexibility of operation. The advantages of low-temperature carbonization are: (1) saving high-heat value constituents and (2) rich primary gases. The lack of development of these processes in this country is because the many uses of gas are not realized, few persons are interested in complete gasification, and the adverse attitude of public utilities commissions toward spending money for developing new processes. Complete gasification may develop continuous water-gas generators and gasification at the mines and transmission to industrial centers through pipes. G.W.W.

Air preheating. S. C. MILLER. *Power Age*, Oct., pp. 26–27, 1927.—The preheating of combustion air for steam-boiler furnace, which has been extensively used in marine practice for over 30 years, has within the last 2 or 3 years been applied to a considerable number of land installations. The reason for this is the increased recognition of the stage extraction, or "bleeder" system, of feed heating. The heat formerly recovered by the economizer is transferred by the preheater to the combustion air. It is claimed that 70% of the waste heat in the flue gases can be recovered, and boiler efficiency is raised from 77.6 to 90.7%. H.H.S.

BOOKS

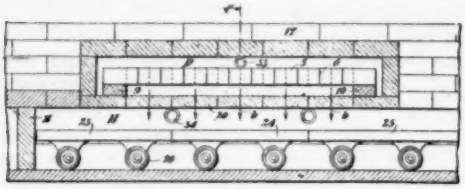
Industrial Furnaces. W. TRINKS. Vol. I, 2nd ed., 352 pp.; Vol. II, 1st ed., 405 pp. New York: John Wiley and Sons, Inc., 1927. Vol. I deals with the principles which underlie furnace design and operation, and with those applications which are independent of the nature of the fuel or energy supply. Vol. II deals with fuels and sources of heat energy, combustion devices, control of temperature and atmosphere, labor-saving appliances, comparison and choice of fuels, and furnace types. Price Vol. I, $4.50; Vol. II, $5.50. H.H.S.

Electric Furnaces. W. RODENHAUSER, J. SCHOENAWA, AND C. H. VON BAUR. 3rd ed., 444 pp. New York: John Wiley and Sons, 1927. Price $4.50. Types, materials, construction, and costs. H.H.S.

Flow of Gases in Furnaces. W. E. GROUM-GRJIMAILO. Translated from the French by A. D. Williams. 399 pp. New York: John Wiley and Sons, 1927. Price

$5.50. Based on the hydraulic theory of the flow of hot gases, which has had a far-reaching influence upon the working out of new forms of furnaces. H.H S.

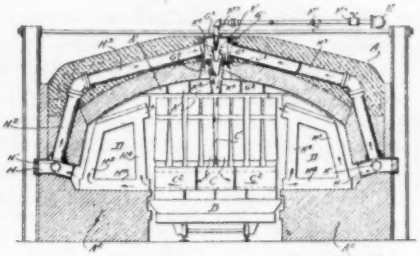
Britain's Fuel Problems. Introduction by Sir Alfred Mond. London: Reviewed in *Fuel Economist*, 1927. Price 42*s*. Composite work of 50 specialists. Introductory articles deal with fuel economy in the U.S. and other countries, and 9 sections are devoted respectively to production, preparation, use, carbonization, low-temperature distillation, gasification, interior heating, efficiency, and refractories. H.H.S.



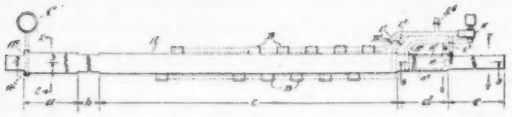
PATENTS

Electric furnace. FRANCIS A. J. FITZGERALD. U. S. 1,646,058, Oct. 18, 1927. In an electric furnace, a heat chamber having a lining comprising coalescing blocks of Carborundum.

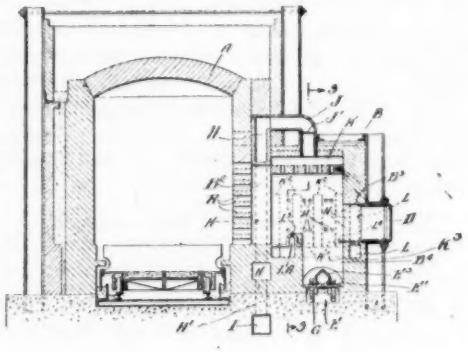
Tunnel kiln. PAUL A. MEEHAN. U. S. 1,646,208, Oct. 18, 1927. In a kiln, means for circulating the kiln chamber atmosphere comprising a channel in the kiln-chamber wall opening to the kiln chamber at separated points and an injector having a mixing chamber adjacent one of the channel openings.



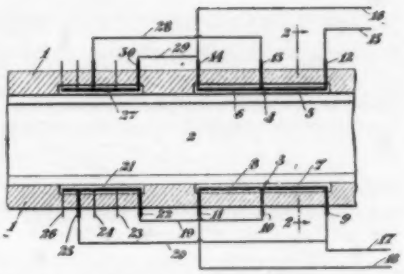
Tunnel kiln. PAUL A. MEEHAN. U. S. 1,646,254, Oct. 18, 1927. In an open-fire tunnel kiln having side-wall flues along a section of the kiln adjacent its entrance end and draft-creating means for drawing heating gases from the kiln chamber into and through the flues, the improvement which consists in walls between the flues and the kiln chamber comprising metal plates suspended from the roof of the kiln, and sealing troughs into which the lower edges of the plates extend.

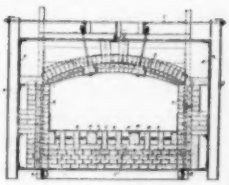


Tunnel kiln. CONRAD DRESSLER. U. S. 1,646,279, Oct. 18, 1927. An open-fire kiln having a fire box at the side of the kiln chamber with a combustion chamber therein and a port opening from the combustion chamber to the kiln chamber, the improvement which consists in cooling channels in the walls of the port and at the sides and top of the combustion chamber, and provisions for passing air through the channels into the combustion chamber to support combustion therein.



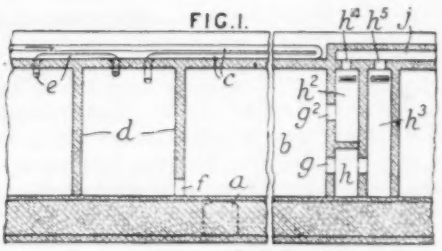
Electric tunnel kiln. JAMES KELLEHER. U. S. 1,647,524, Nov. 1, 1927. A tunnel kiln having an electric resistor heater located in one portion of the tunnel, and means to control the current through the resistor comprising a resistor heater rheostat located in another portion of the tunnel and adapted to control the temperature of the latter portion of the tunnel.

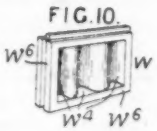


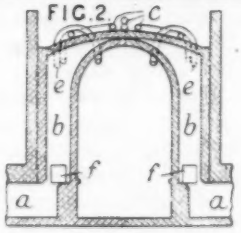


Electric furnace. FRANK T. COPE AND ROLAND F. BENZINGER. U. S. 1,647,726, Nov. 1, 1927. An electric furnace including a floor, piers extended upward from the floor, a hearth comprising a plurality of plates mounted upon piers, and a resistor grid supported between the piers and intermediate the hearth and floor.

Tunnel kilns; bricks. J. MARLOW. Brit. 275,048, Sept. 21, 1927. In a gas-fired tunnel kiln or oven for firing tile, pottery ware, etc., having combustion chambers (*b*) in the side walls; the air for combustion is heated in pipes (*c*) arranged outside of and in close proximity to the crown of the kiln, and is passed to hot air chambers (*d*) adjacent the combustion chambers, and communicating therewith through openings (*f*). Gas is supplied through flues (*a*), and the heating-gases pass at the ends of the chambers (*b*) through openings (g, g^2) to flues (h, h^3, h^2), and thence through damper controlled openings (h^4, h^5) to flues (*j*) at the sides of the crown. Air from the tunnel chamber may be passed to the hot-air chambers (*d*) through pipes (*e*). The combustion chambers may extend upward as far only as the springers of the arch, or the 2 combustion chambers on opposite sides of the tunnel may be connected above the crown. Air-circulating passages, open at both ends to the tunnel chamber, may extend beneath and at the back of the combustion chambers. The side walls of the tunnel may be built of tongued or grooved bricks (*W*, Fig. 10) each having a corrugated panel (w^4) set in a flat frame or surround (w^6).



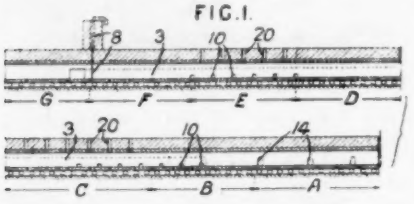




Ceramic ware; tunnel furnaces. BARTON FOREIGN PATENTS, LTD. Brit. 275,104, Sept. 21, 1927. In the manufacture of vitrified paving blocks and other ceramic products in tunnel furnaces the ware is first heated to vitrifying temperature, and is then passed to a cooling zone maintained at a considerably lower temperature than that of the vitrifying zone, after which it is reheated, and then allowed to cool at first slowly and then rapidly. The kiln shown for carrying out the process is fired by powdered coal supplied through

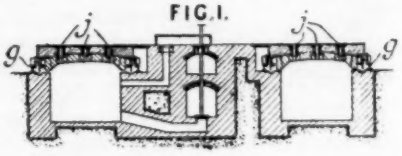
openings in the crown, and the temperature in the 2 firing-zones is controlled by varying the supply of air from side-wall flues (3) through ports (10). A sliding door (8) is provided to cut off the final cooling zone (*G*) from the remainder of the tunnel, and air, either from the atmosphere or from the zone (*G*), is forced into the wall flues (3) by a fan. Heating gases are drawn off at the entrance end of the tunnel by a fan through ports (14). The letters *A-G* represent in order the preliminary-heating zone, a firing zone in which an oxidizing atmosphere is maintained, the vitrifying zone, the 1st cooling zone, the reheating zone, and the 2nd and final cooling zones.

FIG. 1.



Kilns. M. BISCH. Brit. 275,616, Sept. 28, 1927. In order to facilitate charging and discharging, the chambers of a continuous kiln are roofed by movable slabs (*j*). As shown the slabs run on rails (*g*) on the sides of the chambers and can be run at the end of the chamber on to a transfer platform. Alternately the slabs may be moved by a travelling crane or they may be adapted to turn about one edge into a vertical position.

FIG. 1.



Geology

The uses of mica. ANON. *Rock Prod.*, **30** [22], 65 (1927).—The chief use of mica is in the electrical industries, states the U. S. Bureau of Mines, Dept. of Commerce, in telephone, lightning arresters, condensers, commutators, and many special types of equipment. For the glazing of stoves and furnaces, lamp chimneys for gas and gasoline lamps, the mica must be clear, even-splitting, and flexible; little domestic mica is suitable for this purpose. Ground mica is dusted onto roofing material before rolling to prevent sticking. A pound of mica has great covering power because of the flat shape of the thin particles. Ground mica is also used as a decorative material on wall paper and in special paints. F.P.H.

State geological surveys. H. B. KUMMEL. *Sci. Monthly*, **25**, 445–50 (1927).—In the earlier days of a survey, the work must of necessity be more practical than theoretical, but later, greater refinements can be undertaken and broader problems considered. In no 2 states are conditions identical; every survey must in a degree be a law to itself, but in every case the goal should be an accurate report on the resources of the state, their conservation and development. H.H.S.

Feldspar and feldspar production in North Carolina. JASPER L. STUCKEY. *Glass Ind.*, **8** [11], 271–73 (1927); reprinted from *Mfgr's. Rec.*, **41** [26], 63–68 (1927). See also *Ceram. Abs.*, **6** [11], 533 (1927). E.J.V.

Aluminum and bauxite. R. S. MCBRIDE. *Mineral Ind.*, **35**, 11–47 (1926).—World production, metallurgy, new alumina processes, and uses are covered. (*C. A.*)

Silicification of sedimentary rocks. C. W. CORRENS. *Neues Jahrb. Mineral. Geol. Beil.-Bd.*, **52A**, 170–81 (1925).—Silicification of limestones occurs by means of acid or weakly alkaline solutions while in clays silicification is caused by alkaline solutions. (*C. A.*)

Experimental studies on chemical processes in the formation of glacial clay. O. TAMM. *Sveriges geol. Undersökning.*, **18** [5], (1924); *Intern. Rev. Sci. Practice Agr.*, **4**, 347–48.—Clay was artificially prepared by rotating quartz flasks containing small

pieces of granite and H_2O, either free from or containing CO_2, in a thermostat for 12 hrs. The rate of decomposition of the granite was nearly independent of the temperature but was largely dependent on the intensity of grinding and on the amount of CO_2 present. The clays thus prepared were similar to natural glacial clays even in chemical composition. The dissolved bases, MgO, CaO, K_2O, and Na_2O, in water free from and containing CO_2 amounted to 1.17 and 3.24%, respectively of the clay formed at the same time. The content of the 2 clays in chemically dissociated minerals was 15.6% in the presence of CO_2 and 6% without CO_2. The artificial clays appeared to have a higher content of biotite than natural glacial clays. Experiments with K feldspar also indicated a high degree of decomposition and it is concluded that feldspar plays an important part in the change of granite into glacial clay. (*C. A.*)

BOOK

Geology in Building Engineering (Die Geologie im Ingenieur—Baufach.) WALTER KRANZ. Stuttgart: Ferdinand Enke, 1927. Price 31.50M. Reviewed in *Engineering*, **124,** 494 (1927).—As geologist to the State of Württemberg, K. pleads for engineering geologists and for technical geologists. In his researches on the raw material of concrete, he found sand from the bunter sandstone formation inferior to sharp-grained river sand. Other problems discussed are volume, movement of ground water, soil permeability, water absorption, safety of buildings, etc. H.H.S.

Chemistry and Physics

Determination of antimony. H. R. FITTER. *Chem. and Ind.*, **46T,** 414 (1927).—The determination of Sb and Sn in presence of each other is based on the little-known fact that the freshly filtered oxides are completely soluble in oxalic acid. The sample is brought into solution in the usual way and taken down with HNO_3, the oxides of Sn and Sb are filtered on to a glazed filter paper and washed, and without delay washed into a beaker and 30 g. of oxalic acid are added; the liquid is diluted to 100 cc. and kept hot until quite clear. Sb is then precipitated by H_2S in boiling solution, and ignited to Sb_2O_4. H.H.S.

An apparatus for potentiometric titrations. J. F. SPENCER. *Chem. and Ind.*, **46T,** 423–24 (1927).—The apparatus described was designed for the purpose of carrying out titrations in highly-colored solutions. It has proved useful and reliable not only for its special purpose but also for general volumetric work. H.H.S.

Titanium separation from tantalum and niobium. W. R. SCHOELLER AND E. C. DEERING. *Chem. and Ind.*, **46,** 938 (1927).—Previous methods of separating TiO_2 from the earth acids are reviewed and criticized. A more accurate method is given, based on the dissociation of the soluble tartaric complexes of the metallic acids by a mineral acid; the earth acids are precipitated while the Ti salt remains in solution. H.H.S.

The growth of the scientific textbook. J. E. CHANDLER. *Chem. and Ind.*, **46,** 976 (1927).—This is an autumn review number of new books. Twenty-five books are reviewed, and there is an index to books reviewed during the last 6 months. The new lists of recent and forthcoming books of British and American publishers are then given. C.'s article, which is accompanied by another on the reviewing of books, deals with all the well-known textbooks of the last 70 years. H.H.S.

Crystallization. WILLIAM BRAGG. *Chem. and Ind.*, **46,** 1023–24 (1927).—Deals with the study of crystals by X-ray and especially with the effect on crystal faces of "poisoning" by an impurity which need be only one molecule thick. The impurity consists of molecules either all right-handed or all left-handed, and they block up one sort and not the other on the crystal face; thus want of symmetry arises. H.H.S.

Colloidal particles: structure and formation. WILLIAM BRAGG, H. FREUNDLICH, R. W. GRAY, F. L. USHER, AND J. EWLES. *Engineering*, **124**, 509–10 (1927).—An account of the general discussion on colloids at the British Assn. meeting at Leeds. B. explains the use of X-rays in the study of colloids; F. deals with state of aggregation and crystalline form and shape; G. describes his researches on the process of coagulation in smokes and the structure of particles; U. follows with a paper on the formation and growth of particles in systems from which crystalline structure is absent. E. discusses the study of the fine structure of wool by pinhole beams of monochromatic X-rays. H.H.S.

p_H test criticized; the study of acid catalysis. H. M. DAWSON. *Engineering*, **124**, 510 (1927).—D. takes exception to the general view that ascribes the catalytic activity of acids entirely to hydrogen, this being one of the reasons why so much is now heard of H-ion concentration (p_H). He suggests that the observed catalytic effects are the joint actions of H-ions, acid anions, and undissociated acid molecules. When weak acids are mixed with their salts, the reaction velocity diminishes to a minimum and then increases again as the proportion of salt is increased. Plotted against p_H, the reaction velocity gives a catenary curve. D. deduces a general formula independent of temperature, solvent, and the nature of the reaction, and applies his conclusions to buffer solutions, autocatalysis, and the determination of constants. H.H.S.

Viscosity of liquids. E. N. DAC. ANDRADE. *Engineering*, **124**, 462–63 (1927).—Deduces the formula $\eta = C/(T - T_0)^{\frac{1}{2}}$, that is to say, the viscosity at constant volume decreases with rise of temperature and tends to become constant. This agrees with observations. H.H.S.

The nomenclature of silica. GILBERT HART. *Amer. Mineral.*, **12** [11], 383–95 (1927).—The following varieties of silica are described along with some of the physical properties: (1) crystallographic varieties named in order formed with descending temperatures, (*a*) silica glass, (*b*) cristobalite, β and α form, (*c*) tridymite, β second tridymite, β first tridymite, α tridymite, (*d*) quartz, β and α form, (*e*) chalcedony, (*f*) colloidal silica; (2) phenocrystalline varieties; (3) massive and microcrystalline varieties; (4) cryptocrystalline varieties of silica; (5) mixtures and intergrowths of quartz, jasper, and chalcedony; (6) pseudomorphous silica; (7) rocks and other mixtures predominately siliceous. F.P.H.

On the determination of alkalis in rocks and minerals. EARL V. SHANNON. *Amer. Mineral.*, **12** [11], 411–13 (1927).—The method for determining alkalis in minerals as used at the U. S. National Museum is described. Precautions that must be taken in their successful determination are pointed out. F.P.H.

The causes of the plasticity of clay. HERMAN SALMANG. *Zeit. Anorg. u. Allgem. Chem.*, **162**, 115–26 (1927); *Keramos*, **6** [8], 306 (1927).—For abstract see *Ceram. Abs.*, **6** [12], 622 (1927). F.P.H.

X-ray analysis of clays. L. B. STRUTINSKI. *Jour. Russ. Phys. Soc.*, **58**, 314–25 (1926); *Keramos*, **6** [8], 306 (1927). F.P.H.

On the chemical reactivity of minerals and their ions. R. JAEGER. *Keramos*, **6** [8], 291–92 (1927). F.P.H.

Measurement of the permeability of ceramic materials. ANON. *Fuels and Fur.*, **5** [10], 1372 (1927).—An abstract of *Circular*, No. 14, Eng. Expt. Station, Univ. of Ill. A.E.R.W.

On the problem of kaolin formation. ANON. *Sprechsaal*, **60** [33], 589–92 (1927).—A description and discussion of experimental work in connection with the formation of kaolin. R.A.H.

Flotation practice in the Couer d'Alene district, Idaho. A. W. FAHRENWALD. *Amer. Inst. Mining Met. Eng. Tech. Publ.*, No. 1, 18 pp. (1927).—Recent improvements

in flotation have been due to the development of: (1) better equipment, (2) better reagents, and (3) better understanding and control of the process. The name and location of the major companies, the nature of the ore, and the general milling scheme are tabulated; also fine-grinding practice, relation of pulp dilution and load to ball-mill efficiencies, relations of classifier efficiencies to ball-mill efficiency with various per cents of efficiency of classification. Types of flotation machine, reagents and oils used, the quality of the ore dressing, and theory of cost of flotation are discussed. A table shows a general summary of flotation practice results in this district. (*C. A.*)

Flotation mechanism, a discussion of the functions of flotation reagents. A. M. GAUDIN. *Amer. Inst. Mining Met. Eng. Tech. Publ.*, No. 4, 27 pp. (1927).—A theory, based on many tests, is presented to explain flotation. Variables entering into flotation include: characteristics of ore, apparatus, tests, and reagents. A classification is given for flotation reagents with respect to polarity and function. Flotation is regarded as essentially an adsorption phenomenon featuring adsorption at gas-liquid interfaces, adsorption followed by chemical bonding at the surface of certain minerals in the ore, catalytic adsorption, and adsorption not involving further chemical action at solid surfaces. (*C. A.*)

Recent flotation practice at Inspiration, Ariz. G. H. RUGGLES AND H. F. ADAMS. *Amer. Inst. Mining Met. Eng. Tech. Publ.*, No. 5, 17 pp. (1927).—An account is given of the experimental work in changing flotation reagents in the pilot mill. The new reagents are lime, xanthaté, and pine oil; the old were coal tar and pine oil. Flotation reagent added to the ball mill during grinding resulted in the flotation concentration being lower in Cu and higher in insoluble. Na-xanthate was substituted for K-xanthate, gave equally good results, and was cheaper. The proper quantity of Na-xanthate for use was arbitrarily chosen at 0.03 lb. per T. of ore. The new flotation reagents are used throughout the mill and give satisfactory results. Flow sheet and tables accompany the paper. (*C. A.*)

Ore concentration practice of the Consolidated Mining and Smelting Co. of Canada, Ltd. R. W. DIAMOND. *Amer. Inst. Mining Met. Eng. Tech. Publ.*, No. 9, 10 pp. (1927).—A brief description is given of the 3 concentrators located at Kimberley, Movie, and Tadanac, B. C. Successful differential flotation of Zn, Pb, and Fe sulphides began on ore from the Sullivan mine in 1920. Flotation reagents used are soda ash, $CuSO_4$, cyanide, cresylic acid, water-gas tar, coal tar, creosote, xanthate $Na_2Cr_2O_7$, and steam. Lime is found to be unsatisfactory as a conditioning reagent. $CuSO_4$ is used in the Zn-flotation feed water and cyanide as a depressant for the iron pyrites in the absence of much Ag or Au. Xanthate has no advantages over water-gas tar and cresylic acid on any of the B. C. ores treated. $Na_2Cr_2O_7$ has a stabilizing effect upon the Zn float and overcomes the irregularities due to changing Pb flotation conditions. Mill control on mineral content as determined by the microscope used by the mill men is very satisfactory. Their monthly average estimate rarely exceeds 0.05% Zn difference from control assay. A flow sheet for the Sullivan concentrator is included. (*C. A.*)

The temperature coefficient of the dielectric constant of quartz, fluorspar, and gypsum. ALBRECHT DIETERICH. *Ann. Physik*, **81**, 523–36 (1926).—The change in capacity of a condenser on changing temperature was measured at the frequency 6.5×10^5. The temperature coefficients of the dielectric constant $1/\epsilon(\delta\epsilon/\delta t)$ are: fluorspar 2.05×10^{-4}; gypsum 3.75×10^{-4} ($\perp$, 010); Scholt's Minosglas 1.37×10^{-4}; quartz 0.2×10^{-4} ($\perp$ to axis). (*C. A.*)

Application of electroösmosis in the purification of kaolin and clay. ALBERT GRANGER. *Chim. et ind.*, Special No., 438–40, May, 1927.—Description of the plant of the Graf Schwerin Aktien-Gesellschaft, at Chodow, near Karlsbad (Czechoslovakia). (*C. A.*)

Determination of soluble silica in cement, mortar, and concrete, and its application to the estimation of the cement content of mortar or concrete. DANIEL FLORENTIN. *Chim. et ind.*, Special No., 446–48, May, 1927.—A detailed description of determinations of the cement content of a number of mortars of known composition by comparative soluble SiO_2 determinations showed maximum errors of 2% (on the weight of the mortar). (*C. A.*)

H. LeChatelier's viscosity law. P. LAZAREV. *Compt. rend.*, **185,** 106–107 (1927).—LeChatelier's law for the viscosity (η) of glass as a function of the temp. can be written $\log \eta/\eta_0 = N - Mt$, or $\log\eta = \log\eta_0 + 10^{N-Mt}$, or $\eta = \eta_0 10^{10^{N-Mt}}$, in which η_0, M and N are constants. The formula is also accurate in the case of viscous liquids, calculated values agreeing very closely with the experimental values of Thorpe and Rotgen (Landolt-Bernstein, *Physik. Tabellen*, **1** [5], 151 (1923)) for AmOH. Numerous viscosity determinations by the falling-sphere method have shown the formula to be applicable also to molasses and solutions of sugar in glycerol, the average differences between calculated and experimental values being 1.21–1.51% and maximum difference 4%. (*C. A.*)

Fusion-temperature determination. ANON. *Elec. World*, **90,** 415–16 (1927).—Determinations of fusion points of coal, ash, etc., are carried out *in vacuo*. The temperatures are determined by means of an optical pyrometer, or a thermocouple with the junction brought close to the metal strip and properly calibrated. A suitable magnifier with eyepiece covered with a blue-glass solariscope may be placed above the glass and focused upon the specimen. The fusion point is observed as a thin white border which spreads around the specimen; when it becomes visible the pyrometer is read and the temperature recorded. Near complete fusion the specimen loses its roughness and the moment the last rough and somewhat darker spot appears, fusion is complete and the temperature read again. The apparatus is placed in a box to exclude as much light as possible. Specimen should be in direct contact with the strip. Current consumption is about 300 watts. The complete apparatus is illustrated. (*C. A.*)

Molded insulation. L. E. BARRINGER. *Gen. Elec. Rev.*, **30,** 387–95 (1927).—A detailed account covering the important functions of the component materials, the process of molding, properties, and methods of testing. The chapter on binders discusses synthetic resins, natural resins, gums, asphalts, pitches, drying oils, rubber, and silica cements or compounds. Probably the most unique binder is lead. The mixture of lead borate and mica is heated to the softening point of lead borate (675°) and the mass compressed while thus rendered plastic by heat. The moldings are cooled under compression. The fused Pb borate combines with enough mica to form a lead borosilicate, thus providing a greater degree of insolubility and higher softening point than possessed by the lead borate. (*C. A.*)

The specific heats of metals and their melting points. A. I. BRODSKII. *Jour. Russ. Met. Soc.*, **1,** 165–73 (1925); *Jour. Inst. Metals*, **34,** 408–409.—A discussion of Vinogradov's empirical formula for the determination of the values of the mean specific heats of metals between zero absolute and the temperature of fusion T_s: $C_o^{T_s} = 5.45 + 0.00104\ (T_s - 273)$. This formula can be derived from the more general one by Magnus-Lindemann: $C_T = 5.5 + bT$, where b equals 0.0021 for most metals. The linear relation between the specific heats and temperatures, *i.e.*, both the Vinogradov and Magnus-Lindemann formulas, follow from the quantum theory of specific heats. As a first approximation for high temperatures (but not extraordinarily high) the following formulas may be taken: $C_T = 5.5 + 0.0021T$; $C_o^T = 5.17 + 0.00105T$. Both formulas were checked on a series of metals and were found correct within 5%. The 2nd formula is a generalization of Vinogradov's formula; it makes possible the computation of C_T and C_o^T corresponding to any high temperature. The Vinogradov's formula would lead to considerable errors, especially with iron. (*C. A.*)

Formation of layers in clay suspensions. E. UNGERER. *Kolloid-Zeit.*, **41,** 51–54 (1927).—The frequent formation of parallel layers observed in suspensions of clay which are left undisturbed is not a coagulation phenomenon. Observations were made of the particle density of the layers and of their movement in an electric field. The layers are due solely to the size and weight of particles falling in accordance with Stokes' law. The layer formation takes place also in electrolyte-free clays. (*C. A.*)

Amorphous teachings are wrong. P. P. v. VEIMARN AND T. HAGIWARA. *Kolloid-chem. Beihefte,* **23,** 400–27 (1927).—M. L. Frankenheims in 1847 stated that only liquid and gases are amorphous; all rigid substances are crystalline. This hypothesis now becomes an established theory. There is then discussed the expansion of the theory of the crystal to the vectorial constitutions of matter; also V.'s theory and its relation to the structure of colloid particles in connection with the determination of crystal structure in highly dispersed systems in polarized light and by the X-ray methods of Debye-Scherrer-Hull. (*C. A.*)

Research as a business. R. E. ROSE. *Proc. Am. Assn. Textile Chem. Colorists,* 151–56 (1927); *Am. Dyestuff Rept.,* **16,** 489–94 (1927).—An address. (*C. A.*)

Thermal properties of ferric oxide. GEO. G. BROWN AND C. C. FURNAS. *Trans. Amer. Inst. Chem. Eng.*, **18,** 309–46 (1926).—The known specific heat of crystalline Fe_2O_3 is extended from 100–650°. A new allotropic transformation at 360° is reported, and the heat absorbed at this transition is reported as 4.85 cal. per g. The total heat absorbed for all transitions between 650° and 825° is established at 41.8 cal. per g. Advantages and disadvantages of the method for determining the thermal properties of solids are given. The apparatus and its operation are described. Numerous curves and charts and a bibliography are included. (*C. A.*)

The ability to form threads, the surface tension and the specific heat of glasses. G. TAMMANN AND R. TAMPKE. *Z. anorg. allgem. Chem.*, **162,** 1–16 (1927).—The length of a thread that can be drawn from an undercooled liquid is found to be dependent upon the temperature, viscosity, and speed of drawing. For betol: $\log l. = -0.0656t + 2.90$ and for alphol: $\log l. = -0.0767t + 3.48$. With piperine, narcotine, and grape sugar the length of the thread increases faster with decreasing temperature. The relation between length and viscosity for betol is according to the parabola $l.^2 = 2p(\eta - \eta_0)$; $2p = 13.3$; $\eta_0 = 3$g./cm. sec; η_0 is viscosity for $l. = 0$. The length of the thread is inversely proportional to the time of drawing. The surface tension of the above materials was measured to the temperature of the viscosity $\eta = 20$ g./cm. sec. The surface tension and the negative temperature coefficient decrease with increasing temperature. Salicin, brucine, cane sugar, piperine, and grape sugar were investigated to determine their specific heat. The difference between the specific heat of the crystalline and the amorphous salicin is small between 20° and 45°. With brucine and cane sugar the specific heat of the glassy material is larger than that of the crystalline between 20° and 66°, respectively 20° and 86°. The change in specific heat corresponds with the large increase of the expansion coefficient. (*C. A.*)

The dependence of the surface tension of highly viscous liquids on the temperature. G. TAMMANN AND H. RABE. *Z. anorg. allgem. Chem.*, **162,** 17–21 (1927).—(*Cf.* preceding abstract). The shrinking method, provided no moisture can be adsorbed, is useful for viscosities of 10^4 to 10^6 g./cm. sec. From $\eta = 10^6$ to 10^9g./cm. sec. the method of Berrgren can be applied. The surface tension decreases at the higher viscosities with increasing temperature. Salicin, Jena glass, and piperine were investigated. (*C. A.*)

Boric acids and alkali borates. I. The free boric acids. HEINRICH MENZEL. *Z. anorg. allgem. Chem.*, **164,** 1–21 (1927).—The solubility of H_3BO_3 (mols. per 1000 g. H_2O) was found to be 0.760 (18°) and 0.934 (25°). Freezing point depressions indicated

that the acid exists in H_2O solution as the slightly dissociated monomolecular form, although the results were ambiguous. The cryohydrate point was found to be $-0.760 \pm 0.005°$, the cryohydrate concentration being 0.409 ± 0.002. In the presence of H_2O_2 the solubility diminished, indicating no combination; freezing point depressions, though yielding ambiguous results, indicated the same. Conductivity measurements, however, indicated the presence of a perboric acid. Its dissociation constant could not be determined from the available data. **II. The alkali borates in water solution.** *Ibid.*, 22–62.—A physico-chemical study of complex formation in solution by borate ion with H_3BO_3 **(I)** on the one hand and with H_2O_2 on the other. While conductivity measurements led to ambiguous results, cryoscopic investigation of Li, Na, K and NH_4 mono-, bi-, and pentaborates yielded the following: Corresponding concentrations of the alkali salts of a given borate type yielded closely agreeing values for i, the Van't Hoff coefficient, the differences following, in general, the order of hydration, except in the case of the monoborate solutions, where K had relatively the largest value. The monoborates appeared throughout as binary electrolytes with the anion $BO_2 \cdot$ aqueous. In biborate solutions ternary dissociation appeared in the higher concentrations with increasing formation of bivalent tetraborate ions. The perborate solutions which in high dilution are largely dissociated into monoborate and free H_2O_2 show the character of a ternary electrolyte more and more markedly as the concentration increases. In pentaborate solutions the ion $B_5O_8 \cdot$ aqueous is recognized, although it is extensively dissociated into **(I)** and lower polyborates. Except for the monoborate, the NH_4 salts correspond to the alkali salts. The monoborate deviates considerably because of its strong hydrolysis. The literature is critically reviewed. (*C. A.*)

An absolute method for accomplishing quantitative analysis by means of emission spectra. II. EUGEN SCHWEITZER. *Z. anorg. allgem. Chem.*, **164,** 127–44 (1927).—Spectrum analysis has accomplished remarkable results in the detection of small quantities of certain elements but until recently the attempts to determine the quantities of elements have not been entirely successful. As the quantity of an element diminishes in a mixture, certain lines begin to disappear although there are certain lines, called *raies ultimes*, which are very persistent; even these lines gradually grow weaker. In the spectra of different elements there are often lines close together which always appear equally strong for a definite concentration of each element. Thus Sn shows a line at wave-length 2851 which is of the same intensity as the Pb line at wave-length 2833 when 10 atomic % of Pb is present together with 90 atomic % of Sn. In this way lines can be selected which will indicate 10, 3, 2, 1.3, 0.6, 0.1, 0.06, and 0.02 atomic % Pb in Sn. This enables one to estimate very quickly and quite accurately the amount of Pb present as impurity in a sample of Sn. In this paper, tables of these homologous spectral lines are given which can be used for the determination of Pb in Sn, Sn in Pb, Bi in Sn, Cd in Sn, and Bi in Pb. Sometimes the 2 elements in question do not happen to have adjacent homologous lines which can be used in this way but even then the analysis can be accomplished by photographing on the same plate the spectrum of some element that does show suitable lines. The paper will be found interesting to any one desirous of carrying out quantitative measurements with the spectroscope. (*C. A.*)

X-ray method of determining coefficient of expansion at high temperatures. K. BECKER. *Z. Physik*, **40,** 37–41 (1926).—The Debye-Scherrer method was used and the preparation was heated by means of an electric current through a W wire. For W, the linear coefficient from 18° to 2200° $= 7.5 \times 10^{-6}$, from 18° to 1750° $= 6.6 \times 10^{-6}$, from 18° to 1380° $= 5.8 \times 10^{-6}$. For zircon, silicon, silicon carbide and the Nernst filament the values are 4.5, 3.55, 6.25 and 10.7×10^{-6}, respectively, to the temperatures 1300°, 950°, 1200° and 2000°. (*C. A.*)

The chemical combinations of lime and magnesia with ferric oxide. R. NACKEN AND M. E. GRÜNEWALD. *Zement*, **15,** 561–62, 576–78, 589–91, 614–16 (1926).—The

heat curves and compounds formed at high temperatures by mixtures of pure CaO, MgO, and Fe_2O_3 with and without fluxes were studied. A Pt resistance furnace was used. The melting curve of CaO–Fe_2O_3 between 40 and 65 molecular % CaO was found to agree with that described by Sosman and Mervin. $CaO \cdot Fe_2O_3$ in rhombic needles and $2CaO \cdot Fe_2O_3$ in plates are the only compounds found to be produced by these components in the presence of much $CaCl_2$ as flux. $5CaO \cdot 3Fe_2O_3$ is formed at 1200° when the oxides are heated for 2–4 days in equimolecular proportions with a half-molecular weight of $CaCl_2$. With 3 or more CaO to each Fe_2O_3 and a half molecule $CaCl_2$, $2CaO \cdot Fe_2O_3$ is formed. Apparently spinel, $MgO \cdot Fe_2O_3$, is the only compound resulting from MgO and Fe_2O_3 interactions. The formation of $MgO \cdot Fe_2O_3$ at 900–950° in the presence of dry HCl gas requires a catalyzer, Pt serving in this instance. (*C. A.*)

Natural and artificial calcium aluminosilicates. W. Eitel. *Zement*, **15,** 608–10, 646–48 (1926).—A discussion of the constituents in and about the Portland cement field of the CaO–Al_2O_3–SiO_2 temperature diagrams, compared with related natural silicates. (*C. A.*)

Examination of the hydration of dicalcium silicate and tricalcium silicate. Hugo Beckmann. *Zement*, **16,** 37–40, 55–58 (1927).—Hydraulic properties of $2CaO \cdot SiO_2$ and $3CaO \cdot SiO_2$ prepared from pure substances are not equal to those of normal Portland cement. Hydration is a stabilizing process of the unbalanced, multiphase, partly colloidal system. Small quantities of H_2O held apparently as zeolitic H_2O seem greatly to further the hydration processes during the setting of cement. (*C. A.*)

The action of inorganic oxides on aluminosilicates during heating. Bernward Garre. *Zement*, **16,** 290–92 (1927); *Z. anorg. allgem. Chem.*, **164,** 202–206 (1927).—Dried SrO intimately mixed with powdered silicates when heated to 600° for 5 min. was found to react with nepheline, leucite, orthoclase, precipitated SiO_2, quartz, and Al_2O_3 in these amounts respectively, 10.3, 7.8, 6.1, 2.2, 1.9, 13.2%. The reaction products were determined by their solubility in 1% HOAc+NH_4OAc. With the aluminosilicates the Al_2O_3 found was more than 75% of the total silicate dissolved. At 450° and 435° exothermic breaks are found in the heating curves of SrO with SiO_2 and the aluminosilicates though none was observed for SrO with Al_2O_3. At 600° PbO reacted with 4–6.5% of the aluminosilicates. At 710° values about quadrupled. PbO and Al_2O_3 react slowly at 600° but 15% of the Al_2O_3 is rendered soluble. With Pb silicates an alcohol HOAc extraction is necessary to prevent hydrolysis of the salts. (*C. A.*)

The system magnesium-cadmium. W. Hume-Rothery and S. W. Rowell. *Jour. Inst. Metals*, 18 pp., Sept. 1927. (Advance copy.)—The equilibrium diagram of the system magnesium-cadmium has been determined by thermal and microscopical analysis. The system contains a solid solution based on cadmium denoted α, a definite intermetallic compound $MgCd_2$ of fixed composition, and a solid solution in magnesium, denoted β. At ordinary temperatures the limits of the α and β solid solutions are 0–24 and 40–100 atomic-% Mg, respectively. The liquidus and solidus are close together in the whole range of alloys, but do not meet at 50 atomic-% Mg as previously supposed. The compound $MgCd_2$ is formed from β and liquid by a peritectic reaction at 379°, and itself undergoes a peritectic reaction with the liquid at 358° to form the solid solution α. Prolonged annealing is necessary to secure equilibrium in the region 25–40 atomic-% Mg. The β solid solution undergoes a transformation in the range 40–60 atomic-%Mg at temperatures from 200° to 250°, but no change in microstructure could be detected. The temperature of this change rises to a maximum at 54, and not, as previously reported, at 50 atomic-% Mg. (*B. C.A.*),

BOOKS

Introduction to the Scientific Study of the Soil. N. M. COMBER. London: E. Arnold and Co., 1927. Price 7*s.* 6*d.* H.H.S.

Dictionary of Applied Chemistry. Vol. VII. Thalenite to Z. EDWARD THORPE. Revised and enlarged edition with collective index. London: Longmans, Green, and Co., 1927. Price 60*s.* H.H.S.

International Critical Tables of Numerical Data, Physics, Chemistry and Technology. Vol. II. EDWARD W. WASHBURN (Editor-in-Chief). Prepared under the auspices of the International Research Council and the National Academy of Sciences by the National Research Council of the U. S. 616 pp. McGraw-Hill Book Co., Inc., New York, 1927. To be published in 5 volumes. Price $60 per set on orders for sets only; payable at the rate of $12 per volume as issued. Reviewed in *Ind. Eng. Chem.*, **19** [11], 1299 (1927).—The work is a worthy companion to the first volume and will prove valuable for reference to the research scientist as well as to the technologist. It should be especially useful to the industrial chemist, ceramist, and metallurgist. R.J.P.

PATENTS

Production of barium silico-fluoride. HOWARD S. MCQUAID. U. S. 1,648,143, Nov. 8, 1927. The process for the manufacture of barium silico-fluoride which comprises reacting sodium silico-fluoride with a nonalkaline barium compound.

Manufacture of active adsorbent and catalytic masses. I. G. FARBENINDUSTRIE A.-G. Brit. 255,904, July 26, 1926. An irreversible colloid, *e.g.*, silica, alumina, iron oxide, is prepared as a sol or jelly, and, before being dried, is mixed intimately by mechanical means with one or more catalytic substances in the liquid or finely-divided solid state. When the colloid is a sol the mixture is allowed to set to a jelly, dried, and purified by washing before or after complete drying. The catalytic substances or their decomposition products may be removed by acids after drying completely or partially, preferably after saturation with water vapor. (*B. C. A.*)

General

Some observations on the dehydration and firing behavior of clays. R. F. GELLER AND W. H. WADLEIGH. *Jour. Amer. Ceram. Soc.*, **10** [12], 925–55 (1927).—The results of laboratory studies of the drying and watersmoking behavior of twelve clays, typical of those used in the manufacture of clay structural units, are given and correlated with data obtained at plants during the firing of ware made from these same clays. There is evidently considerable difference in the time required to dry the materials investigated and it is indicated that the fire clays as a group are considerably more difficult to dry than are shales and surface clays. The results also indicate that the removal of hygroscopic and chemically-combined water, as initially contained in the clay, are not important factors in regard to the time required to watersmoke and fire clay ware under plant conditions. With proper equipment it would appear to be possible to fire clay ware, approximating brick and paving block in size and shape, to 1832°F in 20 hours, but that the following conditions in practice may necessitate a longer firing time than that shown to be satisfactory in the laboratory: (1) the heating of ware which is not "bone dry" and which necessitates completion of the drying operation in the kiln; (2) the time required to complete oxidation; (3) the limitations necessitated by the kiln construction, the brick work of which may be destroyed by too rapid heating and cooling; (4) limitations of kiln design because of which enormous differences in temperature would develop throughout the setting by too rapid heating; and (5) insufficient movement of furnace gases to remove all water-vapor promptly.

English hosts to American ceramists. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **6** [11], 337–40 (1927).—A discussion of the proposed European trip of the AMERICAN CERAMIC SOCIETY with particular regard to the plants that may be visited in England. A preliminary draft of the itinerary for the 10-day stay in England is given. E.J.V.

Symposium on ceramic education under auspices of Educational Committee. W. KEITH MCAFEE. *Bull. Amer. Ceram. Soc.*, **6** [11], 342–59 (1927).—A general discussion of the method of presentation of ceramic subjects in college curricula, based on a 4-year course, and the difference in courses which are intended to produce ceramic engineers, technologists, and artists. E.J.V.

Iowa Ceramic School enrollment more than satisfactory. ANON. *Clay-Worker*, **88** [4], 279 (1927).—A report of conditions in the Department of Ceramic Engineering of Iowa State College, regarding teaching staff, enrollment, and course of study. E.J.V.

R. C. Purdy goes to Europe to arrange trip. ANON. *Clay-Worker*, **88** [4], 281 (1927); *Mfg. in Can.*, **4** [4], 41 (1927); *Brick Clay Rec.*, **71** [8], 576 (1927).—See also *Ceram. Abs.*, **6** [12], 624 (1927). E.J.V.

National Council of Ceramic Industries. ANON. *Clay-Worker*, **88** [4], 283 (1927); *Brick Clay Rec.*, **71** [8], 566 (1927); see also *Ceram. Abs.*, **6** [12], 625 (1927). E.J.V.

The Ceramic Society. ANON. *Pottery Gaz.*, **52** [605], 1755–59 (1927).—A report of the opening meeting of the 1927–28 session held at Stoke-on-Trent, Oct. 10. In the paper entitled "Three Fundamental Principles of Ceramics," by H. H. Stephenson, the views expressed were that the 3 main principles in which the ceramist is vitally interested are (1) colloidal considerations, (2) silica inversions, and (3) the chemistry of finished and arrested reactions, since clay, under the mechanical processes of pugging, blunging, pressing, throwing, and slip-casting, is subject to changes in its characteristic physical properties. The chemistry of bodies is the chemistry of arrested reactions, whereas the chemistry of glazes is the chemistry of finished reactions. In R. C. Callister's paper on "The Blending of Clays," it was pointed out that the prepared material from which ware is manufactured consists of a mixture of ingredients, the properties of the mixture being resultant upon the properties of these ingredients, and remaining constant from mixing to mixing only in so far as certain factors remain unaltered. Even if the proportions do not vary, unless the ingredients are standard materials as to grain-size, composition, degree of wetness or dryness and previous history, there is opportunity for variation, and this opportunity is enlarged by the difficulties in insuring that the materials are well mixed, as also by their subsequent treatment during working, drying, and firing. Experiments were made in the mixing of a number of English ball clays with English china clays, all of carefully ascertained individual properties. The changes in tensile strength, air-drying shrinkages, firing shrinkages, porosity, and color were carefully noted. The conclusions are: (*a*) The modulus of rupture test gave comparative values of the strength of clays and their mixtures, but in considering the application of the results obtained for individual clays to their binary mixtures more data is desirable. The transverse strengths obtained were only approximately additive. The modulus of rupture of a weak clay was doubled when it was mixed with 25% of its weight of a stronger clay, and quadrupled when the mixture was 50.50. (*b*) The tensile strength tests gave differences of the same order as the transverse strength tests, but they were less obvious unless plotted on an enlarged scale. The strengths of the mixtures in the air-dried state were higher than the average figures over the whole series. (*c*) The air-dried and fired shrinkage data were sufficient to give control of these properties in the binary mixtures; they were approximately additive. (*d*) The varied factors governing porosity and color did not appear to be controllable by averaging, unless the clays were possessed of very similar vitrification rates and ranges under the

particular firing conditions which obtained. In all cases, prior to bloating, the porosity was below that calculated. R. Wentworth Varcoe exhibited a working model of a china clay mine and explained, in nontechnical language, how china clay is produced in Cornwall in what might be described as a hole in the earth resembling a basin. E.J.V.

The Clay Convention at Bournemouth. ANON. *Pottery Gaz.*, **52** [605], 1769–70 (1927).—A report of the gathering of between 300 and 400 representatives of various sections of the clay industry at Bournemouth during the week of Sept. 26, 1927. Some of the addresses delivered at this meeting were: "Themes for Clay Workers," by A. J. Dale, outlining in a general way the queries that are put to technical advisers and some of the unsolved problems connected with the clay industries; "The Clay Products of the Poole and Bournemouth Districts," by H. S. Carter; a paper of topical interest to brick makers by W. F. Higgins; and "The Right and Wrong Uses of Brick and Terra Cotta from the Architect's Point of View," by C. H. Reilley. E.J.V.

A tribute to J. W. Mellor. ANON. *Pottery Gaz.*, **52** [605], 1779–83 (1927).—A memorable function took place at Stoke-on-Trent Oct. 20, 1927, when a complimentary dinner, organized by the Ceramic Society of England, was given to J. W. Mellor, Honorary Secretary of the Ceramic Society and Principal of the Stoke Pottery College, to celebrate his election as a Fellow of the Royal Society. The event drew together a large gathering of admirers of Dr. Mellor and his work, and many high tributes were paid to his scientific attainments and his personal qualities. Dr. and Mrs. Mellor were presented with a beautiful china cabinet containing 2 vases produced in the district, each being a unique specimen of exclusive technique and craftsmanship, the one a Solon pâte-sur-pâte vase produced at the famous Minton factory, and the other, one of the best creations of the talented potter, Bernard Moore. E.J.V.

American Ceramic Society to visit Europe. ANON. *Pottery Gaz.*, **52** [605], 1785 (1927).—An outline of the program to be followed by the AMERICAN CERAMIC SOCIETY in its European tour from May 19–July 5, 1928. E.J.V.

Time-studies in ceramic operations. G. HELM. *Ber. deut. keram. Ges.*, **8** [3], 188–201 (1927). F.P.H.

Cost accounting put to work. J. W. WILEY. *Ceram. Ind.*, **9** [5], 553–54 (1927).—A few of the fundamental shortcomings in connection with the practical application of cost accounting are enumerated. Modern business conditions make it hazardous for the manufacturer to wait for an annual profit-and-loss statement based on physical inventory, to know which way he is heading. He must have this information from month to month. The greater his turnover in proportion to his capital, the more vital it is that he have this information whenever he needs it, with as little delay as possible. A properly conducted cost accounting system will yield this information. F.P.H.

Ceramic short course at Ohio State University given from November 14 to 19. ANON. *Bull. Amer. Ceram. Soc.*, **6** [12], 376 (1927); *Ceram. Ind.*, **9** [5], 568 (1927); *Clay-Worker*, **88** [4], 282–83 (1927); *Brick Clay Rec.*, **71** [8], 582–84 (1927).—Three courses were given by the department of Ceramic Engineering and were divided into the white ware, refractories, and the heavy clay products divisions. The subjects taught in the 3 divisions are given. F.P.H.

Wages and production in Germany and the U. S. WILHELM VERSCHOFEN. *Keramos*, **6** [8], 285–86 (1927).—Comparison of wages and quantity of material produced by German and American workers. F.P.H.

Statistics as a means of successful accounting in management. WILHELM VERSCHOFEN. *Keramos*, **6** [8], 286–87 (1927). F.P.H.

International Congress for Testing Materials. ANON. *Rock Prod.*, **30** [22], 89–91 (1927).—Abstracts of proceedings of the meeting held in Amsterdam, Holland, Sept. 12–17, 1927. F.P.H.

Synchronizing heating processes into straight-line mechanical production. J. B. NEALEY. *Fuels and Fur.*, **5** [9], 1207–12 (1927).—Coördinated mass production in the Fordson plant would have been impossible without the speeding up and synchronizing of straight-line mechanical production. N. shows how this principle has been applied to heating steel ingots, annealing castings, welding, core baking, case hardening, making clutch springs, japanning, brazing crank cases, and making plate glass. The continuous glass plant is described in detail. The furnace tank holds 400 T. of glass, of which 34 T. are poured daily. A.E.R.W.

Protecting the eyes of industrial workers. J. E. HANNUM. *Fuels and Fur.*, **5** [10], 1307–12 (1927).—The eye's susceptibility to injury and inestimable value as a working tool make it imperative that it should not be unduly exposed to danger. Some companies report that they have been able to reduce eye accidents by as much as 90% through the introduction of the proper safety measures. H. describes the National Safety Code for the Protection of the Heads and Eyes of Industrial Workers and lists the publications which may be obtained and which tell when protective measures are necessary and how they may be carried out. The exposure of the unprotected eyes of workers to very intense light sources produces an acute inflammation of the eyes. Continual exposure to intense light and heat may cause the slow development of cataract, especially with workers in molten glass. Correct types of goggles should be chosen and fitted so that they will not cause discomfort. The need for the wider use of goggles is shown by tests of workers' visions which are found to be 54% defective. A.E.R.W.

A year's progress in chemistry. D. H. KILLEFER. *Ind. Eng. Chem.*, **19** [10], 1077–82 (1927).—A review of the last 12 months in chemistry in which the progress in many industries is pointed out. R.J.P.

The economic basis of industrial chemistry. I. WILLIAMS HAYNES. *Ind. Eng. Chem.*, **19** [10], 1082–84 (1927).—The first of a series of articles emphasizing the growing importance of economic considerations in the development of chemical industry. This first article gives a general background. R.J.P.

Economic factors in chemical industry. JOHN E. TEEPLE. *Ind. Eng. Chem.*, **19** [10], 1085–87 (1927).—A definition of a chemical industry is given. Important economic factors such as raw material, power, markets, technically trained personnel, money, etc., are discussed. R.J.P.

The outlook for fuel oil. GEORGE H. ASHLEY. *Combustion*, **17** [3], 163–64 (1927).—Five reasons are given to explain why a few years ago the end of our oil supply was predicted, while today the oil industry is suffering from overproduction: (1) More use is being made of geological information with the result of more productive wells; (2) in large areas in the southern, western, and Gulf regions with underlying oil-bearing rocks covered with overlying nonoil-bearing rocks of much later origin, recent geological methods such as the use of seismographs and microscopic information have opened productive territory which has been a large source of oil not counted on a few years ago; (3) improvement in cables and tools through the use of new alloys makes the drilling of deeper holes possible; (4) the use of artificial pressures which doubles the flow of oil; and (5) the use of pressure in the 1st drilling to get both primary and secondary recovery at the same time. Newer methods of cracking petroleum have increased the supply of gasoline. A. asks, "What of the future?" and answers that the present methods of production with the supplies on hand will serve our needs for 5 or possibly 10 years, and possibly in 10 more years production will lag behind demand and will do so much

more rapidly than the old estimates had anticipated. For a time, with higher selling prices, our needs will be met by importation from South America and possibly elsewhere; finally, before long we shall turn to artificially-produced oil, at first from oil shales, of which there are vast reserves in the western and middle states, probably enough for 100 or 200 years if we devise more efficient methods of burning oil. The use of oil shales means higher cost and higher prices. After the oil shales fail we can obtain oil from coal, and we have vast reserves of low-grade coal in our western states which has already proved suited to the production of oil, but users of fuel oil 10 to 15 years hence must pay a much higher price than at present. G.W.W.

Combustion in Great Britain. ANON. *Combustion*, **17** [4], 234 (1927).—The new "L" type travelling grate stoker is described. The links of cast iron are constructed on an entirely new principle, being a series of free swinging louvres attached to the chain by pivots or small bars. These swinging links catch all riddlings and dust. The riddlings are automatically and continuously discharged so that nothing passes down into the wind box. The free loose links, partial burning out, distortion, or other troubles do not alter the air space. G.W.W.

Combustion in Germany. ANON. *Combustion*, **17** [4], 235 (1927).—The transport of powdered coal by special railway cars in Germany is, in many instances, preferable to pulverizing coal at the place of consumption, especially for small or medium-size plants. Cylindrical vessels with conical bottoms standing upright on the car frame and fitted with special compressed-air nozzles for unloading are giving the best practical results. To insure safety in transport and ease, speed, and perfection in unloading has proved to be a problem solved, as yet, by only 1 or 2 car builders who have tried their skill at this task. Attention is also called to the difficulty in accurately weighing powdered coal in current operation of plants using it. G.W.W.

The relation of research to industry. W. S. JAMES. *Jour. Soc. Automotive Eng.*, **21**, 265–67 (1927). (*C. A.*)

The February issue of the Journal caters to the members of the National Brick Manufacturers Association and the American Ceramic Society in particular, and all other branches of ceramics in general.

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Vol. 7 January, 1928 No. 1

EDITORIALS

INTEGRATION OF INTERESTS IN CERAMIC TECHNOLOGY

The fundamental principles and factors involved in fashioning utility products from the silicate minerals by fusion are the same whether the product be of clay, glass, or glass enamel. An increasing number of people know the truth of this commonality in fundamental principles for all ceramic processes and products.

It is true that different compositions and treatment are needed to produce ware having widely different qualities, but the underlying fundamentals are the same and there is a great likeness in application in the production of all ceramic ware. Glass, whether constituting the whole ware or fused onto metals or bonding the more refractory clay minerals, determines largely the characteristic of all ceramic ware; so much so that the fundamental studies of silicate meltings are of value alike to the ceramic scientists in clay, glass, or glass enamel.

In most of the factory methods and equipment, as in drying and firing, clay workers, no matter how different their product, employ the same science and engineering while the methods and equipment used in glass and glass enamel works are distinctly different and in many respects are unlike those employed in clay products manufacturing, yet the fundamentals are the same and there are many close parallels in their application.

So similar in science and in engineering principles and application are the ceramic industries, it has proved to be advantageous to have all ceramic investigations in the one federal bureau division and to group the collegiate studies on clays, glass, and glass enamels in the one school curricula.

Our plea for the ceramic business executives to combine their interests in scientific and engineering problems relating to ceramic ware production is based (1) on their common desire for low cost and high quality production; (2) on the fact that the federal and state appropriations for ceramic research are very low in proportion to the taxes paid by the ceramic industries and that they will be increased and be more profitably used only when the ceramic industries are united in their demands for employment of these federal and state facilities in ceramic research; (3) on the fact that our universities, well-provisioned and manned for research, are not being induced to devote the share of attention to ceramic problems which is warranted by the economic value of the ceramic industries and ceramic products; and (4) on the fact that since each of the ceramic trade groups are investing large sums of money in research on problems conceived to be of interest alone to each, and since there is a large fund of knowledge which has not yet been put to work with the largest possible productiveness and since there is a great deal of commonality in the employment of this fund of knowledge, the several ceramic industrial groups should federate and employ a staff of research advisors.

Not until the groups of ceramic manufacturers do unite will they be in a position to obtain from the federal bureaus and universities their just share of the total appropriation spent by them in research, nor will they be profiting most from the facts proved and applied in the allied industries.

When one totals the several thousands of dollars appropriated for research by governmental agencies and realizes how small a portion is being used for ceramic research, it is readily evident that $30,000 or even $50,000 spent annually in maintenance of a federated ceramic research council supported by all the industrial ceramic groups would pay handsomely.

The cash saving which would result from elmination of duplicated work and in the application of information already at hand but not generally applied would alone pay the costs of such a federation.

We do not need another organization and the distinctiveness in product makes necessary the continuing of the separate trade associations; the peculiar benefits which accrue from the coöperative gathering and recording of ceramic technology information by members of the AMERICAN CERAMIC SOCIETY has established the importance of main-

taining this SOCIETY as it is. Hence it is that we plead for federation of the ceramic groups in the employment of a research advisor with duties to serve each group, coördinating their interests in the ways and means of obtaining and applying the science and engineering principles which will enable ceramic manufacturers to keep in the fore in the exceedingly rapid industrial progress of the times. If ceramic manufacturers do not safeguard their interests and do not thus obtain their share of the governmental research facilities available, they must inevitably be less favorably placed in trade than are those who make competing products and who are making rapid strides because of improved products for specific purposes developed and proved in our government laboratories.

OUR 1928 MEETING

Hotel Ambassador, Atlantic City

February 5-11

The time interval between January 1 and February 5 is brief. The big meeting is almost at hand. The hotel reports more room reservations than have been made this early for any of the previous meetings. The exhibit spaces are so greatly in demand that the committee is already providing additional booths. This Meeting promises to be the largest and the best in the history of the SOCIETY.

The best thing about meetings of the AMERICAN CERAMIC SOCIETY is the opportunity afforded to exchange views and experiences with persons in a wide variety of ceramic manufacturing. It may seem, on casual thought, that there is not much in common in the production of glass, glass enamel, and clay ware, but fundamentally there is, even in processing. The fundamentals of silicate fusions are the same for all ceramic mixtures, the vitrifying agent in clays being glass. The equilibrium studies that have been of such profound importance to an understanding of the reactions in glass, that have made possible the development of acid proof clay and glass enameled ware, and that have made possible the large scale production of optical glass are of vital concern to the manufacturer of aluminous abrasive grains and wheels and to the manufacturer of terra cotta, china, porcelains, and vitrified clay wares.

All ceramic ware is processed through firing to high temperatures varied according to the silicate reaction required and according to the nature of the product; but the heat reactions and fuel conservation problems are alike in all of them.

The special duty refractories which have been so extensively made and used during the past few years are developments from the researches

on such a wide range of products as grinding wheels, spark plugs, and electrical insulators.

The tunnel kiln method of firing has been extended to ovens for annealing, decorating, and enameling. No heating device has been efficient in any ceramic industry that could not be adapted to any of the others.

If one would benefit from the ideas of others who are manufacturing widely different ceramic products and who are not bound by traditions and long time practices he should attend the meetings of this SOCIETY. It is not an idealistic statement to say that he who would not be provincial in industrial processes should visit factories producing wholly different types of wares and to hob-nob with those who have given study to the possible application to a specific product or process of the fundamentals which are of analogous significance to a wide variety of industrial products and processes. There is a proved value in meeting with fellow ceramists and it is axiomatic that he who shuts himself in and shuts his industrial neighbors out is cheating himself out of the most effective way of making progress and of keeping abreast of the times.

The railroads are coöperating by giving a one and a half fare concession on the certificate plan, the certificate to be obtained at point of departure when purchasing the one way ticket.

Come—stretch your mind! It will exhilarate you physically and mentally and send you back to your plant job with a broadened vision and increased facilities.

PAPERS AND DISCUSSIONS

A GLASS FACTORY IN THE DAYS OF NEBUCHADNEZZAR

By A. E. Marshall

Introduction

The origin and development of early manufacturing arts always provides some interesting speculations, and archaeologists through excavations and studies of hieroglyphic and cuneiform texts are adding facts to the speculations, so that slowly we are developing useful chronologies of the historical appearance of materials.

Glass and ceramics have always been accorded a prominent place in such studies, probably because they represent the conversion of familiar materials into products with new and distinct physical characteristics. De Blancourt in his "Art of Glass" written in the Seventeenth Century says,

> Man, in many things, is capable of imitating nature by the assistance of art, and of performing several things by his industry and the work of his hands, which look more like miracles than the effect of art. Of all the works of art, that of glass is not the least considerable.

Metallurgy, which appears to have preceded glass, had its starting point in the working of native metals such as copper, gold, and meteoric iron, and after the metal working technique had been developed there followed the conversion of ores to metals.

Discovery of Glass

Until recently the discovery of glass was attributed to the Phoenicians, those ancient seafarers who provided the ships for Mediterranean commerce and who possibly ventured out of the Strait of Gibraltar, north to England for tin and south to the west coast of Africa for gold. The blue beads found in Druidic mounds in England and the "Aggri" beads of the Ashantis in west Africa are very similar to beads discovered in Phoenician excavations and not unlike Egyptian beads of the Eighteenth Dynasty. They may have been a medium of barter like the red handkerchiefs and muskets of a later age.

The alleged origin of glass in Phoenicia can be traced back to certain of the early writers particularly Josephus, Tacitus, Strabo, and Pliny. Their stories differ slightly in details but have a general background of accidental discovery. Pliny's tale is most widely known: how some Phoenician mariners were driven ashore on the sands at the mouth of the river Belus by a storm, and when they could find no stones to support their cooking pot over a fire, went back to their ship for some blocks of "Natron" which happened to be part of the cargo. When the fire was burning brightly the sailors were surprised to see a clear

rivulet of molten material, which quickly solidified into glass, appearing where the "Natron" blocks rested on the sand.

Phoenicia dates from the Sixteenth Century B.C., and as glass was made at least two thousand years earlier, the stories are apocryphal, but like many of the olden tales they employ some facts because white sand from the Belus and "Natron" from Egypt were constituents of ancient glasses.

The nationality and location of the first glass workers has not been definitely placed at the present time because our views of Egypt as the birthplace not only of glass but of pottery, copper tools, bronze, etc., are subject to modification through explorations and discoveries of civilizations which seem to have existed in Asia Minor prior to the first Dynasty in Egypt. Ancient Sumer, Babylonia, Assyria, Elam, and Mesopotamia now rival Egypt as happy hunting grounds for archaeologists, and while many years of arduous labor, in excavating and properly coördinating the discoveries, will be required to fit these ancient peoples into their correct places in history, enough evidence is already at hand to indicate the possible existence of a civilization antedating the earliest Egyptian records.

Sumerians We do know that an early civilized race, the Sumerians, came out of southern central Asia and settled in what was later Babylonia and part of Assyria, prior to the founding of the First Egyptian Dynasty. These Sumerians, unlike the contemporaneous Egyptians, were familiar with and used the potter's wheel. They produced pottery which ranks among the finest ever made; they built canals, used pictographic writing, and even at that early date gave evidence of a still earlier history of arts and manufactures.

So far Sumerian glass has not been discovered, but this is not an indication of its nonexistence for the total of the Sumerian explorations is small and much remains to be uncovered.

It is interesting to note that Sumerian influences can be traced in Predynastic Egypt. The motif of serpent-headed monsters with interlaced necks is Sumerian and appears also in the earliest Egyptian art; cylinder seals and linear pictographic writing as found at Susa, the ancient capital of Sumer, are also found in Egyptian tombs of slightly later dates. Whether these discoveries indicate that Sumerians were the parent stock of the Egyptians or that the two races were distinct and that Egypt was once under the sovereignty of Sumer is still beyond solution, and because the question is one dealing with the happenings of 7000 years ago at the dawn of history, it is likely to remain an unsolved problem, or at least one with an uncertain answer.

The Sumerians have a place in this paper because Sumer once embraced Assyria in its empire, and the 650 B.C. glass factory of Ninevah,

though operated by Assyrians, may have owed something of its wonderful state of development of the glass manufacturing art to this much earlier people. Glass beads are common objects in the tombs at Ur, which date back to about 2500 B.C., and some day the cycle of historical development may enable us to fill in the gaps between 2500 B.C., and 650 B.C., and between the beads of 2500 B.C., and the first discovery of glass.

Ninevah Glass Factories

We are fortunate in that we have, thanks to R. Campbell Thompson, a very complete picture of the glass factory at Ninevah as it existed in the reign of Assurbanipal (668–626 B.C.). Explorations at Ninevah have yielded much useful information on the status of civilization in Assyria, but to the scientific worker nothing else has an interest equal to the inscribed cuneiform tablets discovered there and recently translated by Mr. Thompson. The tablets are factory records giving the complete details of preparing frits and glasses, coloring agents, fuel for the furnaces, and the method for starting up a furnace.

Raw Materials

The primary raw materials for glass production are sand, alkali, and lime or lead; so one of the first questions which occurs to the glass technologist studying the Ninevah records is the type of raw material used, for there were many available sands and several forms of alkali and lime.

Thompson found the word "sand" of the texts was not the usual Assyrian for sand, but one denoting some special characteristics and by an interesting series of philological connections he indicates this special sand might have been sand from the river Belus, particularly as Syrian caravans in later years carried Belus sand to distant glass factories. The sand used was therefore of special quality and probably a quartz sand.

The alkali was not "Natron." Egypt was far away and the salt marshes of the Tigris and Euphrates delta were covered with Salicornia plant grasses which on burning gave an impure sodium carbonate ash. "Natron" was not a particularly good raw material for glass as it was a variable mixture of carbonate, bicarbonate, chloride, and sulphate of soda with the chloride content sometimes as high as 30% NaCl.

It is interesting to note that Bacon speaks of the Venetian glass workers purchasing salt grass alkali from Alexandria in the Fifteenth Century. Alexandria was an export point for "Natron" so the choice of salt grass alkali seems to evidence knowledge of its superiority for fine glass production. Some recent analyses of Twelfth and Eighteenth Dynasty Egyptian glasses indicate salt grass ashes as the probable alkaline constituent, for all contain around 2% potash.

The third element in Ninevah glass was not lead but lime. Thompson

translates this part of the text as "a white mineral softer than limestone" and therefore probably chalk. Lead does not appear in any of the glass compositions but it is one of the constituents of a bronze foundation for a silver overlay (possibly a mirror) described on one of the other Ninevah tablets.

Batch Starting with the translation of the principal constituents, Mr. Thompson then premises that in the texts the glass frits will be referred to by a special name, or its components must be detailed, or the previous description of the frit production must be used as a reference, and on this basis he divides the texts into two classes: (*a*) formulas with details of the full components and (*b*) formulas where a special name is used for the base.

The entire texts show the Ninevah works prepared definite bases or frits in fairly large batches, then the frits after cooling were broken up and small batches of specially colored glasses were made by adding coloring agents to the frits.

The composition of one of the simple glasses or clear frits is: 60 parts sand, 180 parts salicornia alkali, 5 parts saltpeter, and 2 parts chalk.

The next recipe has the same proportions of sand and alkali but then follows 6 parts saltpeter, $\frac{1}{2}$ part chalk, 3 parts oxide of tin, and $\frac{3}{10}$ part oystershell; obviously the product was a white opaque glass such as was used for seals.

To list all the formulas would make this paper too long so the following is an enumeration of the materials used for coloring the various compound glasses: antimony sulphide, arsenic trisulphide, gold, oxide of copper, cinnabar, oxide of manganese, ferric oxide.

The glasses produced seem to have been, in addition to crystal and opaque white, lapis blue, blue, pale blue, violet, black, brown, green, coral red, red-purple, opaque red, yellow, and a magical glass which unfortunately is in incomplete form.

The quantities specified are sometimes by parts and sometimes by weight, so from the weight formulas we can deduce something of the size of the operations. The crystal glass formula calls for 20 mana of sand, 1 talent of alkali, 2 mana of saltpeter, 10 shekels of chalk, 6 shekels of oyster shell, and 1 mana of oxide of tin, which together amount to a little over 90 pounds. Another frit is also melted in 90-pound batches, so considering the problem of attaining a sufficient temperature with a wood fire, the batch size can be said to at least equal the probable facilities.

The various colored glasses, made by remelting the frits with additional coloring agents, were worked in 1 to 4 pound batches, possibly because the finished colored glass articles were all small in size, a view

borne out by the predominance of small glass articles discovered in the excavations, and the very rare occurrence of larger pieces such as the well-known Sargon vase.

Furnaces The description of the furnace and the ceremonies connected with putting it in operation are sufficiently interesting to justify reading this part of the translation in full:

> When thou settest out the [ground] plan of a furnace for "minerals," thou shalt seek out a favourable day in a fortunate month, and thou shalt set out the [ground] plan of the furnace. While they are making the furnace, thou shalt watch [them], and shalt work thyself (?) [in the house of the furnace]: thou shalt bring in embryos . . . . : another (?), a stranger shall not enter, nor shall one that is unclean tread before them: thou shalt offer the due libations before them: the day when thou puttest down the "mineral" into the furnace thou shalt make a sacrifice before the embryos: thou shalt set a censer of pine-incense, thou shalt pour kurunna-beer before them.
>
> Thou shalt kindle a fire underneath the furnace and shalt put down the "mineral" into the furnace. The men whom thou shalt bring to be over the furnace shall cleanse themselves, and [then] thou shalt set them to be over the furnace.
>
> The wood which thou shalt burn underneath the furnace shall be styrax, thick, decorticated billets which have not lain [exposed] in bundles, [but] have been kept in leather coverings, cut in the month of Ab. This wood shall go underneath thy furnace.

From the details of materials used and varieties of glass produced we have direct evidence of the excellent state of the glass manufacturing art in Ninevah 2500 years ago, and we can only speculate on the years which must have intervened between the first discovery of glass and its development to the stage represented in these tablets.

We certainly cannot use the progress from Ninevah to our own time as a measure of probable time requirements, as we would then have to place the initial discovery far beyond the historical period of our world's history.

BALTIMORE, MD.

ACTIVITIES OF THE SOCIETY

CERAMISTS' TOUR ABROAD

The time is shortening, space on the S. S. Tuscania for May 19 sailing is rapidly being taken and our friends abroad are wanting to know how many and who are members of the tour party. Those who are considering taking this tour, therefore, should reach their decision as soon as possible. Those who are working to make this trip profitable to the tour members are in need of prompt coöperation if the trip is to be all that our hosts desire it to be.

FIG. 1.—S. S. Tuscania (gross tonnage 17,000). One class cabin steamer.

Outline of the Tour

May 19 (Saturday) Sail from New York. S. S. Tuscania.
May 28 (Monday) Due in Paris.
May 29 (Tuesday)
10:30 A.M. Visit the plant of A. Lacroix, manufacturer of vitrifiable colors and ceramic enamels.
2:45 P.M. Visit the crucible factory of the Rousseau Kilns Co. at Argenteuil.
5 P.M. Return to Paris.
8 P.M. Dinner given by the Society of French Manufacturers of Ceramic Products.
May 30 (Wednesday)
9 A.M. Leave in automobiles for Sèvres.
10 A.M. Arrival at Sèvres. Visit the National Manufactury of Sèvres and its museum.
12 M. Leave Sèvres.
12:30 P.M. Arrival at Versailles. Lunch at Versailles.
2–5 P.M. Visit the Palace of Versailles, the Great and Small Trianon, the hamlet of Marie Antoinette.
5:30 P.M. Return to Paris.
May 31 (Thursday)
8:30 A.M. Leave in automobiles for Mantes (On the banks of the Seine, 40 km. from Paris.)
10:30 A.M. Arrival at Mantes. Visit the tile works of Cordeliers. (Lamure, Managing Director.)
12:30 P.M. Lunch at Mantes.
2 P.M. Leave Mantes for Gargenville.
2:45 P.M. Arrival at Gargenville. Visit the cement plant of Poliet and Chausson.
5 P.M. Return to Paris.
June 1 (Friday) Choice of two trips.
I. Visit to Compiègne and the plant of the St. Gobain Co. at Thourotte.
9:25 A.M. Leave North Station.
10:41 A.M. Arrival at Compiègne.
11 A.M. Visit the Chateau of Compiègne (Residence of Louis XV, Napoleon I, and Napoleon III.)
12 M. Lunch at Compiègne.
2 P.M. Visit the plate glass works of the St. Gobain Co. at Thourotte.

FIG. 2.—J. M. Lob, Chairman, Dutch Ceramic Society, Goedewaagen, Amsterdam. Reception Committee in Holland.

7 P.M. Arrival at Paris.
II. Visit tile works of Gilardoni Bros. at Essones and the Chateau of Fontainebleau.
10 A.M. Arrival at Essones. Visit the tile works of Gilardoni Bros.
11:30 A.M. Leave Essones in automobiles.
12:45 P.M. Arrival at Fontainebleau. Lunch.
2 P.M. Visit the Park of Fontainebleau and the Chateau. (Residence of Francois I, Louis XV, and Napoleon I.)
4 P.M. Return to Paris.

June 2 (Saturday)
9–12 M. Visit the principal porcelain stores. Supplementary trips, each of one day duration.
I. Beauvais. National Tapestry Manufactury and tile works.
8:50 A.M. Leave Paris by train.
11 A.M. Arrival at Beauvais.
11–12 M. Visit the National Tapestry Manufactury.
12:30 P.M. Lunch.
2 P.M. Visit the large tile works of Beauvais (Doffoy, Managing Delegate.)
5:30 P.M. Return to Paris.
II. Visit factory of the French Cement Co. at Couvrot and a visit to Epernay.
10:30 A.M. Arrival at Vitry-le-Francois.
11 A.M.–1 P.M. Visit cement factory at Couvrot.
1:30–3 P.M. Lunch.
4 P.M. Leave Vitry.
5:15 P.M. Arrival at Epernay. Visit one or two champagne cellars.
6:45 P.M. Return to Paris.
III. Boulogne sur Mer. Visit factory of the Ceramic Products and Refractories Co.
11 A.M. Arrival at Boulogne sur Mer.
11 A.M.–12:30 P.M. Visit the town and ramparts.
2:30 P.M. Visit the factory: refractory products; retorts for gas producers; terra cotta units and designs; sanitary stone ware.
6 P.M. Return to Paris.

June 3 (Sunday) Leave Paris 8:45 A.M. Arrive Basle (French Depot) 4:21 P.M. Leave Basle (Swiss Depot) 7:02 P.M. Arrive Lucerne 8:40 P.M.

June 4 (Monday) Free day in Lucerne.

June 5 (Tuesday) Climb the Rigi.

June 6 (Wednesday) Leave Lucerne 8:33 A.M. Arrive Zurich 9:42 A.M. Leave Zurich 1:13 P.M. Arrive Munich 9:10 P.M.

For Those Visiting Nancy

June 3 (Sunday) Leave Paris 8:45 P.M. Arrive Nancy 1:40 P.M.

June 4 (Monday) Visit glass factories.

June 5 (Tuesday) Leave Nancy 11:25 A.M. Arrive Munich 4:30 P.M.

June 6 (Wednesday) Free day in Munich.

June 7 (Thursday) Sightseeing in Munich.

June 8 (Friday) Leave Munich 8:20 A.M. Arrive Eger (cheb) 1:44 P.M. Leave Eger 2:00 P.M. Arrive Carlsbad 4:01 P.M.

June 9 (Saturday) Visit porcelain school, kaolin mines, porcelain factory. Meeting in old town hall.

June 10 (Sunday) Leave Carlsbad 9:35 A.M. Arrive Prague 4:25 P.M.

June 11 (Monday) Visit in Prague. Dinner.

June 12 (Tuesday) Leave Prague 12:35 P.M. Arrive Dresden 6:59 P.M.

June 13 (Wednesday) Convention in Dresden. *A.* Ceramic raw material (Endell); *B.* Ceramic industries (Junzeblutt); *C.* American Ceramics; *D.* Dinner.

June 14 (Thursday) Dresden. Visit Meissen porcelain works. Kauffman works. Minsterberg stone works.

FIG. 3.—H. Mulderije, Secretary, Dutch Ceramic Society, (barrister-at-law) Amsterdam. Reception Committee in Holland.

June 15 (Friday) Leave Dresden 7:30 A.M. Arrive Berlin 10:43 A.M. Afternoon motor through city of Berlin.
June 16 (Saturday) Visit Berlin porcelain works. High tension porcelain insulator works. Crain glass works. Dr. Harkort's low fired stoneware works.
June 17 (Sunday) Leave Berlin (Friedrichstrasse) 8:20 A.M. Arrive Cologne 7 P.M.
June 18 (Monday) Glass convention in Cologne.
June 19 (Tuesday) Leave Cologne 5:50 P.M. Arrive Amsterdam 11:05 P.M.
June 20 (Wednesday) Visit Amsterdam. Leave 9:06 P.M.
June 21 (Thursday) Arrive London 8:38 A.M.
June 22 (Friday) London.
June 23 (Saturday) Windsor and Hampton court by motor.
June 24 (Sunday) Leave London for Birmingham via Shakespeare country.
June 25 (Monday) Visits to Birmingham glass works.
June 26 (Tuesday) Fireclay works and Porcelain works at Worcester.
June 27 (Wednesday) Leave Birmingham 8:30 A.M. Arrive Stoke-on-Trent 9:51 A.M.
June 28 (Thursday) Stoke-on-Trent and Sheffield.
June 29 (Friday) Visit works in Sheffield 8:27 P.M. Liverpool 10:45 P.M.
June 30 (Saturday) Sail S. S. Tuscania for New York.

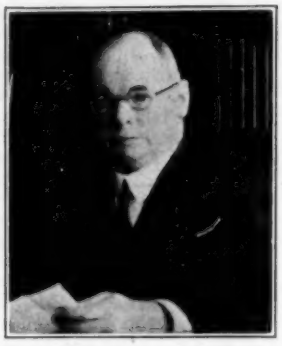

FIG. 4.—W. Hoyng, Managing Director, Art-Pottery Works "Glateelbakkery," Gouda, Holland. Reception Committee in Holland.

FIG. 5.—A. Goedewaagen, Jr. Managing Director, N. V. Goedewaagens' Koniklyke Hollandsche Pijpen-en Aarderkfabricken, Gouda, Holland, Reception Committee in Holland.

Program for Holland

June 19, 1928
11 A.M. Visit to the National Picture Gallery (Rijksmuseum, Rembrandt "Night Watch.") Visit to the diamond cuttery-works, Asscher.
1 P.M. Luncheon.
2 P.M. Visit to the "Dam" square and the "Royal Palace" (renowned "Burgerzaal").
3 P.M. Sight-seeing; old and new parts of Amsterdam.
4–6 P.M. Official trip through the harbor and canals of Amsterdam, offered to the AMERICAN CERAMIC SOCIETY by the Town Council. Tea.
7 P.M. Supper in the "Vondelpark-Paviljoen."
June 20, 1928
9:30 A.M. To The Hague by special train.
10:30 A.M. Visit to the "Huis ten Bosch"; one of the Queen's mansions.
11:30 A.M. Visit to the Picture Gallery; "Mauritshuis," the Parliamentary Buildings; a ceramic-exhibition, to be arranged by Dr. J. van Gelder, at The Hague.
1 P.M. Luncheon.
2 P.M. Visit to the "Palace of Peace."

3 P.M. Trip to Scheveningue and the North Sea shore; tea; supper.
8 P.M. By special train to "Hook of Holland" and embarkation for England.

Visit to St. Austel Clay Mines

For those who will accept of the hospitalities of the producers and importers of the Cornwall clays there will be the trip from London Saturday night, a Sunday on the ocean beach, and a royal welcome at the Mines.

When our friends abroad complete their arrangements for the plant tours no better opportunity can ever be offered to see our fellow industrialists across the sea. This is the main objective of the tour. And to make it worth while in turn to our European and British friends we must make this a truly American party with representatives from all ceramic activities.

FIG. 6.—Walter Sessions, Managing Director, North Cornwall China Clay Co., Ltd.

Why a Ceramic Tour?

The Ceramists' Tour Abroad is offered to meet an insistent demand by American industrialists and artists for first-hand information on ceramic markets, manufacturing processes, merchandising methods, general business conditions, and such similar facts as are known to lead to increased business. The tour gives each member an opportunity to glean valuable information

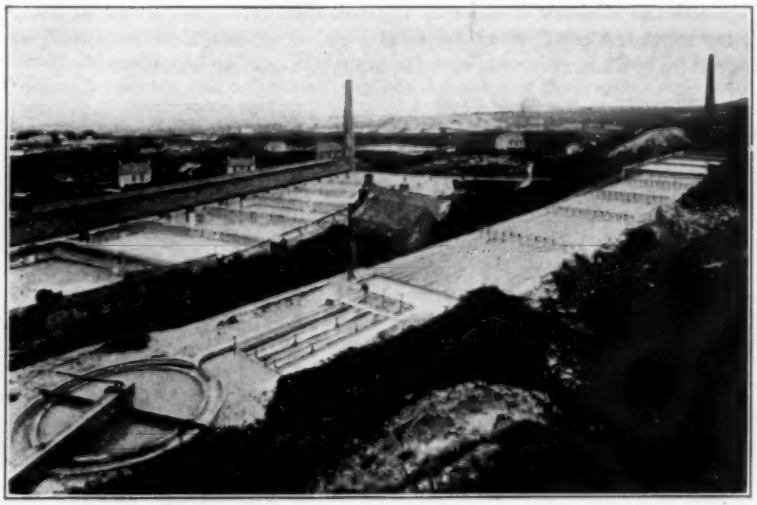

FIG. 7.—Mica settling tanks, Cornwall, England.

of actual monetary value to him and to his firm and at the same time enables his family to enjoy the social side of European travel with proper care and guidance.

The ceramic industries of Europe offer a constantly growing problem to America and while the New World with its modern methods has forged ahead with startling rapidity,

FIG. 8.—K. Endell, professor a. d. Technischen Hochschule zu Berlin, Germany, Chairman Reception Committee in Germany.

yet there are many things hidden away in the Old World from which we may learn much.

A Tour Better Than Individual Travel

Many a man has been heard to say, "I wouldn't go on a tour of any kind. When I go abroad I want to go alone and enjoy myself in my own way." That man is perfectly right if the tour he refers to contemplates throwing all kinds of people with all kinds of interests into one large party. The Ceramic Tour however contemplates nothing of the kind. It will consist of one group of congenial persons with one common interest—ceramics. The entire membership will be split up upon arrival in London into various smaller groups according to individual interests, such as: (1) porcelain and china, (2) glass ware, (3) white ware, (4) refractories, (5) brick, and (6) ceramic arts and decorations, etc., etc.

While there will be occasional mass conferences with our European brethren in the various large capitals of the world, the plants generally visited and the meetings held will be purely sectional—according to the interests of the various members. To duplicate the itinerary of this tour for individual travel would cost at least three times the membership fee; much more, as a matter of fact, if an individual were to attempt to make similar contacts with the heads of European industries.

What Does the Tour Cost?

The membership fee for the tour is $900 per person and this is particularly inexpensive when one considers the places visited, the hotel accommodations furnished, the conference and entertainment programs laid out, and the entertainment arranged by our foreign hosts who are anxious to prove to us their sincere friendship.

In estimating the cost, it should be remembered that for a small family there will be a tremendous saving of household expenses on this side, consequently the actual cost of the tour would be the price of membership less the amount one would spend at home during the same period of time.

FIG. 9.—R. Rieke, Director Berlin Porcelain Works, Germany; Reception Committee in Germany.

What Does the Price Include?

The membership fee includes comfortable cabin accommodations on a Cunard Liner at the listed rate of $145 each way per person. Should you desire better accommodations than these, they can be obtained at a slight additional charge according to the standard fares of the Cunard Steamship Company.

The price also includes all railroad fares and steamer transportation in Europe, including comfortable room accommodations in high grade hotels, and three meals a

day in accordance with the customs of the countries visited. It also includes transportation of members between railroad stations, hotels, and piers.

FIG. 10.—Walter F. Steger, chemist of Berlin Porcelain Works; member of Government Patent Office in Berlin; Reception Committee in Germany.

FIG. 11.—Herman Hecht, joint owner of chemical laboratory for Tonindustrie, and associate editor; editor of Keramische Rundschau; Reception Committee in Germany.

It includes a handsome traveling case which is given each member without charge upon the signing of the application. This traveling case is specially designed for European travel, unusually strong and handsome, and has the name of the owner neatly painted on the end. It is a case which we have tested for two years and which we know will suit the owner's needs admirably.

All sightseeing programs in the various cities, automobile and cabs, etc., are included in the cost. All tips and fees to hotel servants and porters in France, Holland, Germany, Czechoslovakia, and Switzerland are included. The price also covers all admissions to public buildings, etc.

FIG. 12.—E. Cramer, director and general manager Tonindustrie Zeitung Laboratories. Reception Committee in Germany.

What the Price Does Not Include

The membership fee does not include tips aboard the steamers on the Atlantic, the cost of your passport, the cost of the United States war tax (this is $5 per person), wines not ordinarily served on the regular bill of fare, or personal items such as laundry. It does not include hotel tipping in England, as the English hotel owners resent tipping en masse.

With these few exceptions, the membership fee covers practically everything in the way of expenses. Hence when you consider the number of weeks this small amount of money covers, the number of miles traveled, the number of places visited, and the valuable business information obtained, you will see how inexpensive the tour really is.

How to Register

Simply fill in the application form (sent upon request) giving as full information as possible, so that we may arrange for your entertainment and reception in the best possible manner. A deposit of $100 per person should accompany the application blank and an additional $250 per person must be paid by April 1, as by that time the steamship accommodation must be paid for in full. These amounts will be credited to the final payment which is due no later than May 1.

As rapidly as payments are made to the Ceramic Tour Headquarters suite 656, 25 Broadway, New York, they will be acknowledged. You will receive a specially planned itinerary and notebook together with your traveling case a little later on.

It will be to your advantage to make application as early as possible so that we can obtain good space for you aboard ship.

NEW MEMBERS RECEIVED FROM NOVEMBER 1 TO DECEMBER 1, 1927

PERSONAL

Geo. A. Calvert, Estevan, Sask.

Jean Delecourt, 115 Rue Nationale, Marcq-en-Baroeul, Nord, France, fabricant de briques.

Ralph B. Dimmick, 404 North Main St., Butler, Pa., Chief Metallurgist, Columbia, Steel Co.

Richard D. Ferguson, 2637 Ash St., Denver, Colo., interested in floor and tile.

Maurice Geudelin, 22 Rue de l'Argentine, Beauvais oise France, Director Tuileries de Beauvais.

Philip H. Jung, 314 Washington St., Huntingdon, Pa., Consulting Chemical Engineer.

Yukiji Kobayashi, Engineer, Amagasaki Bottle Factory, near Kobe, Japan.

Spencer Le May, c/o Weir Scott & Co., Casilla 73-V, Valparaiso, Chile.

Harry H. Richard, 1426 West State St., Trenton, N. J., Roessler & Hasslacher Chemical Company.

H. M. Robertson, 1262 Hanna Bldg., Cleveland, Ohio, President, Robertson & Co., Inc.

Allen L. Simison, Ceramic Engineer Berney-Bond Glass Co., Columbus, Ohio.

Herbert S. Thynne, Victoria Tile Works, Hereford, England, Director, H. & G. Thynne, Ltd.

Glenn D. Williams, 863 Amherst Pl., Brentwood Hgts., Los Angeles, Calif., Mold Maker, Santa Monica Brick Co.

STUDENT

C. M. Griffin, Ga. School of Technology, Atlanta, Ga.

James H. Page, Ohio State Univ., Columbus, Ohio.

James D. Tetrick, Univ. of Illinois, Urbana, Ill.

Membership Workers' Record

PERSONAL		STUDENT	
F. A. Harvey	1	A. I. Andrews	1
R. B. Keeler	1	A. V. Henry	1
R. D. Landrum	1	A. S. Watts	1
J. P. Nikonow	1		
Geo. Simcoe	1	Total	3
David Thomason	1		
Office	7		
Total	13	Grand Total	16

NEWS FROM THE LOCAL SECTIONS

California Section

The California Section of the AMERICAN CERAMIC SOCIETY, met in Los Angeles on on November 14. A paper entitled "Notes on Construction and Operation of a Hadfield-Penfield Grinder" was presented by C. R. Minton of the Gladding McBean Company. Mr. Minton gave comparisons of tonnages and differences in characteristics of the clays ground in this machine *vs.* the standard nine-foot dry pan.

I. B. Branham, of the Batchelter-Wilson Tile Co., described the "Construction and Operation of a Mold Release Drier" in which 3- x 3-inch tile, previously pressed in a circular plaster mold are inserted in a sloping track which enters a humidity drier, doubles on itself and returns to the presser. Filled molds are inserted at a height of six feet and withdrawn at a two-foot height, where the partially dried tile are removed. The mold is then ready to be filled and put through another trip through the drier.

"A Method of Clay Handling and Blending" was presented by C. R. Minton. In this paper the clay handling machinery of the Los Angeles plant of the Gladding McBean Company was described.

T. S. Curtis, of the Vitrefrax Company, gave a paper on the "Microscopic Study of the Structure of Ceramic Materials." This paper was accompanied by lantern slides showing the development work done by the aid of the microscope in building a refractory to the maximum resistance to abrasion and slagging. Mr. Curtis has done a major part of the microphotography in natural colors which has been of great benefit in interpreting results.

Chicago Section

The Chicago Section met at the Great Northern Hotel, December 10, 1927. The following officers were elected: D. F. Albery, chairman; F. E. Hodek, vice chairman; W. W. Wilkins, secretary-treasurer; F. L. Steinhoff, chairman of Program Committee; G. G. Hansen, chairman of Membership Committee; C. W. Parmelee, councillor. It was decided to hold three joint meetings of the Chicago Enamelers' Club and the Chicago Section during 1928. Ross C. Purdy outlined the Ceramists' Tour Abroad, telling of his experiences in Europe last October.

Pacific Northwest Section

The annual winter meeting of the Pacific Northwest Section will be held January 20 and 21 in the New Mines Building, University of Washington. The program has been planned as follows:

G. L. Rogers, Ceramic Engineer, Gladding McBean and Company, will talk on some recent fire brick testing at Renton. W. J. Howard, Secretary, Brick and Tile Association, will report the work of the Pacific Coast Building Code Commission and his recent visit to Phoenix, Arizona. A representative of the Washington Surveying and Rating Bureau will talk on the relation of insurance rates to construction; Edward Burkhalter, Ceramic Engineer, Washington Brick Lime and Sewer Pipe Company, on his recent experiments in developing faience tile at Clayton, Washington; Karl E. Lieb, College of Business Administration, University of Washington, on a business subject connected with the clay industry; H. F. Faulkner of the Seattle Testing Laboratory on municipal specifications for building materials; Reports from the Ceramic Engineering Department at the University of Washington on kiln testing and spray evaporators; E. E. Saunders, Secretary and Treasurer of the American Fire Brick Company, Spokane, on some recent developments in fire brick testing.

At the dinner dance Saturday evening Edwin J. Ivey, prominent Seattle architect will deliver an address on his recent observations of the architectural use of clay products in Europe.

Pittsburgh Section

The regular monthly meeting of the Pittsburgh Section was held in the Fellows Room, Mellon Institute, Pittsburgh, Pa., at 8:15 P. M. December 13, 1927. J. C. Boudreau talked on "Art and Its Field or Possibilities in the Ceramic Industry," and F. H. Rhead spoke on "The Technical Requirements of Ceramic Art."

Officers for 1928 were elected as follows:

Irwin Sohn, chairman; George E. Sladek, vice chairman; R. F. Ferguson, secretary; C. G. Denney, treasurer; E. W. Tillotson, councillor.

A smoker will be held January 10 in the Fellows Room of Mellon Institute at which Ross C. Purdy will talk on the value of the Ceramists' Tour Abroad May 19 to July 5, 1928.

Michigan-Northwestern Ohio Section

Constitution and By-Laws

1. Name

This organization shall be known as the Michigan-Northwestern Ohio Section of the AMERICAN CERAMIC SOCIETY.

2. Purpose

The purpose of this Section of the AMERICAN CERAMIC SOCIETY shall be to strengthen and extend the work of the SOCIETY, as defined in Section 1 of its rules, by means of more frequent meetings than are possible to the SOCIETY as a whole, and by bringing the benefits of the work to persons who would not otherwise be reached.

3. Membership

(*a*) All members of the AMERICAN CERAMIC SOCIETY, residing within the territory of the Section, shall be entitled to membership and to all the privileges of the Section, including the right to vote and to hold office.

(*b*) Nonmembers of the SOCIETY may become local members of the Section and shall be entitled to a limited participation in the affairs of the section as provided in the By-Laws.

(*c*) The Membership Committee of the Section shall have full power in the election of members and notification of such election shall be made by the committee at the next following meeting of the section.

4. Dues

(*a*) The annual dues of the Section shall be determined by the Executive Committee.

(*b*) Any member of the Section in arrears for over one year may be suspended from membership by the Executive Committee of the Section until such arrears are paid, and in the event of continuous dereliction may be dropped from the rolls.

(*c*) Members in arrears are not eligible to vote.

(*d*) The annual dues are payable within three months succeeding the date of the Annual Meeting.

5. Officers and Committees

(*a*) The officers of the Section shall be a Chairman, a Vice Chairman, a Secretary-Treasurer, and a Counsellor.

(*b*) The affairs of the Section shall be managed by an Executive Committee, consisting of the Chairman, Vice Chairman, Secretary-Treasurer, Counsellor, Junior Past Chairman, and the Chairmen of the Program and Membership Committees.

(*c*) The officers shall be elected for a period of one year and shall be eligible for re-election. They shall assume office at the end of the Annual Meeting and shall hold the same until their successors are elected and installed.

(*d*) The duties of all officers shall be such as usually pertain to their offices or may be delegated to them by the Executive Committee of the Section.

(*e*) Vacancies in any office shall be filled by appointment by the Executive Committee, and the new incumbent shall hold office until the next Annual Meeting of the Section.

(*f*) On failure of any officer to execute his duties within a reasonable time, the Executive Committee, after duly warning such officer, may declare the office vacant.

(*g*) Four members of the Executive Committee shall constitute a quorum at any meeting but the Committee shall be permitted to carry on any business it may desire by correspondence.

(*h*) The Program Committee and Membership Committee shall each consist of two members in addition to the Chairman. These two members shall be appointed by the Chairman who shall also have power to fill any vacancies in his Committee. It shall be the duty of the Program Committee to make arrangements for the programs of the meetings of the SOCIETY. It shall be the duty of the Membership Committee to pass upon all applications for membership in the Section and to take necessary steps to bring desirable new members into the Section as rapidly as possible.

6. Elections

Not less than six weeks preceding the Annual Meeting of the Section, the chairman shall appoint a Nominating Committee of three members, not officers of the SOCIETY, and this Committee shall make nominations for all the officers of the SOCIETY and shall send the names of the nominees to the Secretary-Treasurer at least thirty days before the Annual Meeting. Any other three members of the Section may act as a self-constituted Nominating Committee and also present names of nominees to the Secretary provided this is done at least fifteen days before the annual meeting. The names of all nominees shall be placed on the ballot without distinction and this ballot shall be mailed by the Secretary to every member of the section together with notices concerning the Annual Meeting.

Election shall take place at the Annual Meeting, the voting to be by ballot, and a plurality of votes being sufficient to elect. The votes shall be collected and counted by a committee of three appointed by the Chairman at the Annual Meeting and the results of the vote shall be reported immediately upon completion of the count.

7. Meetings

The Annual Meeting of the Section shall take place during the second week in May at such a place as the Executive Committee shall decide.

At this meeting the annual reports of the Executive Committee, the Secretary-Treasurer, the Program Committee, and the Membership Committee shall be received and the accounts of the Secretary-Treasurer shall be audited by a committee of three appointed by the Chairman.

Other meetings of the Section shall be held at such times and places as the Executive Committee shall decide with the general understanding that at least three other meetings per year shall be held in the months of October, December, and March. Eight members shall constitute a quorum at any regular meeting and a majority shall rule unless otherwise specified.

The order of business shall be as follows: (1) program, (2) reading of the minutes of the last meeting, (3) reports of officers, (4) reports of committees, (5) old business, (6) new business, (7) election of officers, (8) installation of officers, and (9) adjournment.

8. By-Laws and Amendments

The Section shall establish such By-laws as it may desire, and Amendments to the Constitution may be made at any regular meeting providing the amendment signed by

three members of the Section be placed in the hands of the Secretary not less than fifteen days preceding the meeting at which it is to be acted upon.

When notices concerning the meetings of the Section are sent by the Secretary it shall be the duty of the Secretary to include with these notices a statement of any amendments which are to come up for action at the meeting.

By-Laws

1. Membership

Nonmembers of the AMERICAN CERAMIC SOCIETY may hold any office in this Local Section, which does not require contact with or voice in the affairs of the national SOCIETY.

NOTES AND NEWS

OBITUARIES

A. H. Chandler

A. H. Chandler, manager of the refractories department of the Pittsburgh Plate Glass Co., and member of the AMERICAN CERAMIC SOCIETY since 1918, died January 1, 1927.

Byron B. Goldsmith

Byron B. Goldsmith, vice president of the American Lead Pencil Co., and member of the SOCIETY since 1918, died September 8, 1927.

CERAMIC SHORT COURSE AT UNIVERSITY OF ILLINOIS

A Short Course in Clay Working and Enameling will be held by the Department of Ceramic Engineering, University of Illinois, Urbana, Illinois, January 9–21. This course is designed for the benefit of anyone interested in the application of scientific principles to the various branches of the Ceramic industries, which includes heavy clay products of various kinds, refractories, pottery bodies, glazes, and vitreous enamels on metals.

The attendance in the past has been made up of kiln firemen, foremen, superintendents, chemists, managers, and owners of plants of a great variety. Men from almost every state in the union have attended the courses as they have been held from time to time. There is no fee charged for this course.

PROPOSED SIMPLIFIED PRACTICE RECOMMENDATION NO. 79

Sizes and Shapes of Tile and Brick For Malleable Foundry Refractories[1]

In accordance with the unanimous action on November 10, 1927, of the general conference of manufacturers, distributors, users, and interested associations, the U. S. Department of Commerce, through the Bureau of Standards, recommends that the stock shapes and sizes of brick and tile for malleable foundry refractories be limited to the following simplified list.

SECTION I. DOOR OPENING TILE

5 x 9 x 24 in. (See Fig. 1, DT 1)
5 x 13½ x 24 in. (See Fig. 1, DT 2)

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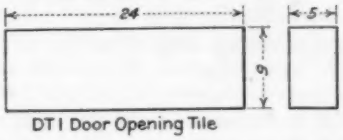
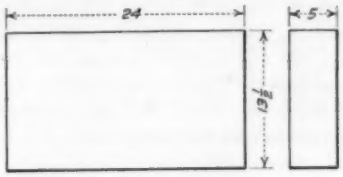
[1] Received December 5, 1927.

(I)
Miscellaneous Shapes

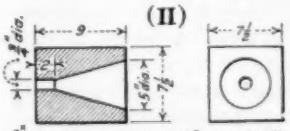


DT 1 Door Opening Tile

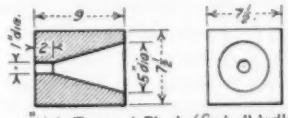


DT 2 Door Opening Tile

(II)

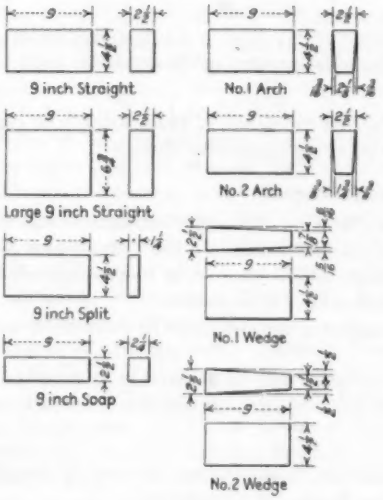


¾" Hole Tap-out Block (for hand ladle)

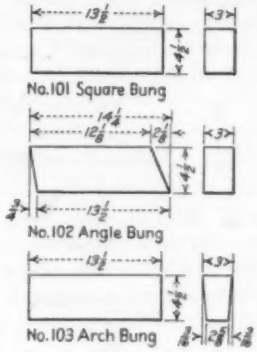


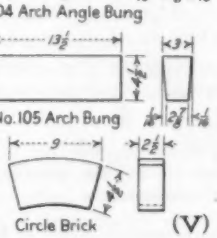
1" Hole Tap-out Block (for bull ladle)

(III)
9 Inch Series



(IV)
13½ Inch Series





(V)

Circle Brick	Inside Diam.	Brick to a Circle
24"	24"	12
36"	36"	16
48"	48"	20
60"	60"	24
72"	72"	28
84"	84"	32

SECTION II. TAP-OUT BLOCKS

Outside dimensions $7\frac{1}{2}$ x $7\frac{1}{2}$ x 9 in., with suitable flare from the hole to the face to allow room for the tapping rod and plugging up. One block to have a $\frac{3}{4}$-in. diameter hole for foundries using hand ladles. (See Fig. 1, TO 1.) One block to have a 1-in. diameter hole for furnaces served with bull ladles. (See Fig. 1, TO 2.)

SECTION III. SHAPES FOR SIDEWALLS, BRIDGE WALLS, ETC.

Classification	Sizes in inches
9-in. straight	9 x $4\frac{1}{2}$ x $2\frac{1}{2}$
" large straight	9 x $6\frac{3}{4}$ x $2\frac{1}{2}$ (for breaking joints)
" soap	9 x $2\frac{1}{2}$ x $2\frac{1}{4}$
" split	9 x $4\frac{1}{2}$ x $1\frac{1}{4}$
Arch 1	9 x $4\frac{1}{2}$ x ($2\frac{1}{2}$–$2\frac{1}{4}$)
Arch 2	9 x $4\frac{1}{2}$ x ($2\frac{1}{2}$–$1\frac{3}{4}$)
Wedge 1	9 x $4\frac{1}{2}$ x ($2\frac{1}{2}$–$1\frac{7}{8}$)
Wedge 2	9 x $4\frac{1}{2}$ x ($2\frac{1}{2}$–$1\frac{1}{2}$)

SECTION IV. SHAPES FOR BUNGS AND ROOFS

Classification	Sizes in inches
Square Bung 101	$13\frac{1}{2}$ x $4\frac{1}{2}$ x 3
Angle Bung 102	($13\frac{1}{2}$–$12\frac{1}{4}$) x $4\frac{1}{2}$ x 3
Arch Bung 103	$13\frac{1}{2}$ x $4\frac{1}{2}$ x (3–$2\frac{3}{8}$)
Arch Angle Bung 104	($13\frac{1}{2}$–$12\frac{1}{4}$) x $4\frac{1}{2}$ x (3–$2\frac{3}{8}$)
Arch Bung 105	$13\frac{1}{2}$ x $4\frac{1}{2}$ x (3–$2\frac{7}{8}$)

SECTION V. SHAPES FOR ROUND STACKS

Circle brick	Sizes in inches
24-in. circle	9 x $4\frac{1}{2}$ x $2\frac{1}{2}$
36 " "	9 x $4\frac{1}{2}$ x $2\frac{1}{2}$
48 " "	9 x $4\frac{1}{2}$ x $2\frac{1}{2}$
60 " "	9 x $4\frac{1}{2}$ x $2\frac{1}{2}$
72 " "	9 x $4\frac{1}{2}$ x $2\frac{1}{2}$
84 " "	9 x $4\frac{1}{2}$ x $2\frac{1}{2}$
Wedge 1	9 x $4\frac{1}{2}$ x ($2\frac{1}{2}$–$1\frac{7}{8}$)
Wedge 2	9 x $4\frac{1}{2}$ x ($2\frac{1}{2}$–$1\frac{1}{2}$)

SECTION VI

Upon depletion of present stocks the eliminated items shall be considered as specials and extended delivery dates are to be anticipated.

SECTION VII

It is recommended that in the issuance of new catalogs or lists only standard items be shown. If specials are also exhibited, some designating mark should be used to indicate the standards.

This recommendation is to become effective February 1, 1928, subject to regular annual revision by a similar conference or standing committee thereof.[2]

History of the Project

Early in February, 1923, interest in simplification of foundry refractories was manifested on the part of the American Foundrymen's Association, the Refractories Manufacturers Association, and individual producers of refractories, in coöperation with the Division of Simplified Practice of the Department of Commerce.

Sleeves, nozzles, and runner brick were selected for reduction in variety, as having the most potential possibilities.

Meetings of representative organizations were held and the matter received discussion at considerable length. The project, however, was devoid of any definite action during 1924 and 1925.

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[2] Promulgation recommended: Edwin W. Ely, Acting Chief, Division of Simplified Practice; R. M. Hudson, Assistant Director, Bureau of Standards.

Upon organization of the Joint Committee on Foundry Refractories, during the latter part of September, 1925, simplification and standardization was incorporated as one of its major activities. Subcommittees were appointed by the Joint Committee, and during the past two years concentrated effort on the part of these subcommittees has resulted in some very definite progress.

The activities of James R. Allan, Chairman of the Subcommittee on Refractories for the Malleable Industry, resulted in a definite recommendation to the Joint Committee at its session in Chicago on June 6, 1927, for certain sizes and shapes of refractories to be approved as tentative standards for the malleable industry.

The Joint Committee adopted these standards, placing them before the entire industry for consideration and at the same time requested the Division of Simplified Practice of the Department of Commerce to call a general conference in Washington on November 10, 1927, for the final adoption of the recommendation and its incorporation in the Department's Elimination of Waste series.

Report of General Conference

In compliance with the request of L. C. Hewitt, General Chairman of the Joint Committee on Foundry Refractories, under date of September 16, 1927, formal invitations were extended to manufacturers, distributors, users, and interested associations, to attend a general conference in Washington on November 10 to consider the adoption of definite shapes and sizes of brick and tile for malleable foundry refractories.

Most of the replies to the invitation indicated that the Joint Committee would be empowered to represent their interests.

A tentative agenda prepared from the report of the Subcommittee on Malleable Foundry Refractories was submitted to the Joint Committee in Chicago on June 6, 1927, and served as a basis for discussion at the meeting.

As the tentatively recommended sizes and shapes were available for the consideration of all interested parties for four months, very little discussion resulted from the general conference. Some discussion was had on the part of the manufacturer as well as the user, in the case of tap-out blocks. Where several comments were received by mail, and they were placed before the conferees for their consideration, it was decided to make no changes in the proposed standards.

In the case of shapes for bungs, there existed a sentiment on the part of mail criticism for the retention of the 9-inch size which has long been standard within the industry. The conferees, however, were fully cognizant of the progressive step incident to the elimination of the 9-inch bung, feeling that better practices of the industry would result if all types of furnaces used the 13½-inch series.

The entire program received the unanimous vote of the conference and the action taken means the elimination of 173 variations, the reduction being from 188 to 15.

The conferees appointed the existing Subcommittee on Malleable Foundry Refractories to serve as the Standing Committee of this recommendation, the personnel of which is as follows: H. M. Thompson, Chairman, H. M. Thompson Co., Chicago, Ill.; J. H. Birdsong, Metallurgist, Buffalo, N. Y.; and James R. Allan, International Harvester Company, Chicago, Ill.

Those in attendance were: James R. Allan, International Harvester Co., Chicago, Ill.; C. E. Bales, The Ironton Fire Brick Co., Ironton, Ohio; M. C. Booze, Charles Taylor Sons Co., Cincinnati, Ohio; J. T. Bottom, Bureau of Engineering, Navy Department, Washington, D. C.; J. L. Cummings, American Foundrymen's Association, Riverside, Ill.; W. H. Funk and Fred A. Harvey, Harbison-Walker Refractories Co., Pittsburgh, Pa.; R. A. Heindl, Bureau of Standards, Washington, D. C.; L. C. Hewitt, Laclede-Christy Clay Products Co., St. Louis, Mo.; J. T. MacKenzie, American Cast

Iron Pipe Co., Birmingham, Ala.; H. M. Thompson, H. M. Thompson Co., Chicago, Ill.; L. J. Trostel, General Refractories Co., Baltimore, Md.; P. G. Willetts, Hartford-Empire Co., Hartford, Conn.

H. R. Colwell represented the Division of Simplified Practice, Dept. of Commerce, Washington, D. C.

CALENDAR OF CONVENTIONS

AMERICAN CERAMIC SOCIETY		
Annual Meeting	Feb. 5–11, 1928	Atlantic City N, J.
Ceramists' Tour Abroad	May 19–July 5, 1928	
Amer. Chemical Society	April 16–20, 1928	St. Louis, Mo.
Amer. Concrete Institute	Feb. 28–Mar. 1, 1928	Philadelphia, Pa.
Amer. Concrete Pipe Assn.	Jan. 24–26, 1928	New Orleans, La.
American Electrochemical Society		
(Spring Meeting)	April 26–28, 1928	Bridgeport, Conn.
(Fall Meeting)	Sept. 20–22, 1928	Charleston, W. Va.
Amer. Engineering Council	January, 1928	Washington, D. C.
Amer. Foundrymen's Assn.	May 14–18, 1928	Philadelphia, Pa.
Amer. Gas Assn. (Natural Gas Dept.)	May, 1928	Dallas, Texas
Amer. Institute of Architects	May 9–11, 1928	St. Louis, Mo.
Amer. Inst. Mining and Met. Engrs.	February, 1928	New York City
Amer. Soc. Mechanical Engineers		
(50th Anniversary)	April 7, 1928	Washington, D. C.
(Spring Meeting)	May 14–17, 1928	Pittsburgh, Pa.
Amer. Soc. Steel Treating		
(Semi-Annual Meeting)	Feb. 16–17, 1928	Montreal, Can.
(Annual Meeting)	Oct. 8–13, 1928	Philadelphia, Pa.
Amer. Zinc Institute	April 16–18, 1928	St. Louis, Mo.
Assn. of Sci. App. Makers of Amer.	May 5–7, 1928	Atlantic City, N. J.
Common Brick Manufacturers Assn.	Feb. 13–17, 1928	Washington, D. C.
Engineering Foundation	Feb. 16, 1928	New York City
Glass Container Assn.	Feb. 2–3, 1928	New York City
Hollow Building Tile Assn.	February, 1928	Chicago, Ill.
Mfg. Chemists Assn. of U. S.	June 2, 1928	New York City
Mining and Met. Soc. of Amer.	Jan. 10, 1928	New York City
Natl. Acad. of Sciences	April 23–25, 1928	Washington, D. C.
Natl. Assn. of Mfgrs.	Oct., 1928	
Natl. Assn. Mfgrs. Heating and Cooking Appliances	May 9–10, 1928	Detroit, Mich.
Natl. Brick Mfgr. Assn. (Meeting jointly with the AMERICAN CERAMIC SOCIETY)	Feb. 5–11, 1928	Atlantic City, N. J.
Natl. Clay Prod. Ind. Assn.	April, 1928	Chicago, Ill.
Optical Soc. of Amer.	October, 1928	Washington, D. C.
Sand-Lime Brick Assn.	Feb. 1–3, 1928	Washington, D. C.

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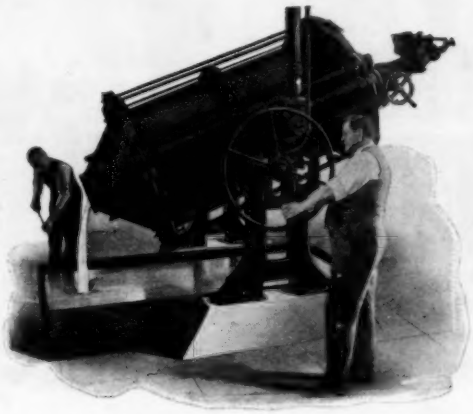

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Welsh Tinplate & Metal Stpg. Co., Ltd., Llanelly, England.
Ernest Stevens, Limited, Cradley Heath, England.
Ward Leonard Electric Company, Mount Vernon, N. Y.
American Enameled Products Co., Chicago, Ill.
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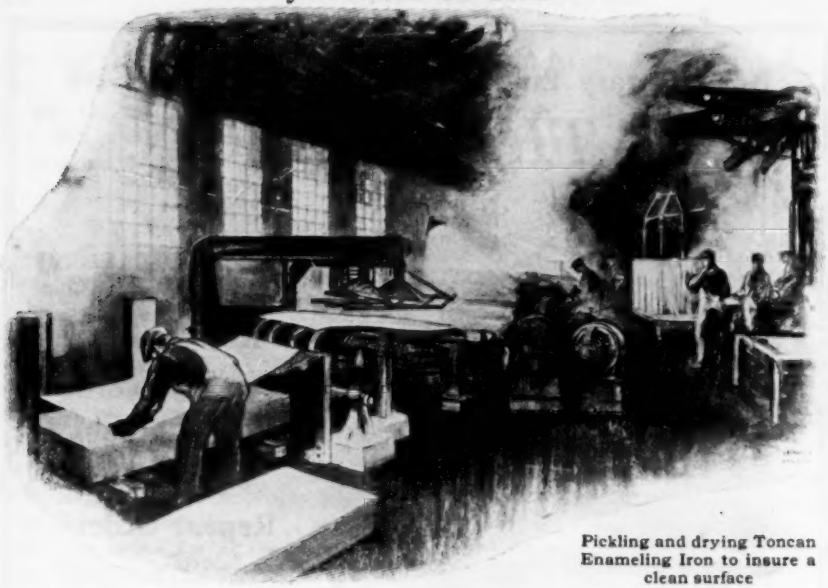

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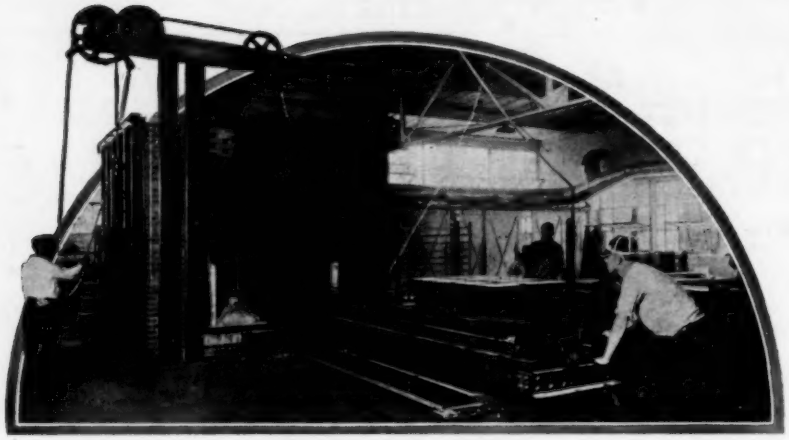

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ALPHABETICAL LIST OF ADVERTISERS

	Page
American Gas Association	31
American Potash and Chemical Corp.	41
American Rolling Mill Co.	34
Brown Instrument Co.	2
Carborundum Co.	30
Central Alloy Steel Corp.	8
Chambers Brothers Co.	37
Chicago Vitreous Enamel Product Co.	41
Classified Advertising	26
Drakenfeld and Co., B. F., Inc.	18
Edgar Brothers Co.	37
Engelhard, Chas., Inc.	40
Exolon Company	39
Ferro Enamel Supply Co.	41
Fisher Governor Co.	10
Fisher Scientific Co.	14
General Electric Co.	27
Harbison-Walker Refractories Co.	29
Harshaw, Fuller and Goodwin Co.	4
Innis, Speiden & Co., Inc.	33
Journal of the Society of Glass Technology	26
Jungmann & Co.	22
Kentucky-Tennessee Clay Co.	29
Lake County Clay Co.	37
LaMotte Chemical Products Co.	33
Leeds and Northrup Co.	1
Massillon Stone & Fire Brick Co.	32
Maxon Premix Burner Co.	33
McDanel Refractory Porcelain Co.	35
McLanahan Watkins Co.	39
Metal & Thermit Corp.	Outside Back Cover
Montgomery Porcelain Products Co.	37
Mueller Machine Co.	35
National Silica Co.	12
Norton Co.	20
Pacific Coast Borax Co.	39
Paper Makers Importing Co., Inc.	16
Pennsylvania Pulverizing Co.	36
Pennsylvania Salt Mfg. Co.	41
Philadelphia Drying & Machinery Co.	42
Potters Supply Company	12
Proctor and Schwartz, Inc.	38
Professional Directory	28
Roessler and Hasslacher Chemical Co.	Inside Front Cover
Seaboard Feldspar Co.	29
Spinks, H. C. Clay Co.	24
Titanium Alloy Mfg. Co.	Center of Book 6
United Clay Mines Corp.	29
U. S. Smelting Furnace Co.	7
Vitro Manufacturing Co.	36

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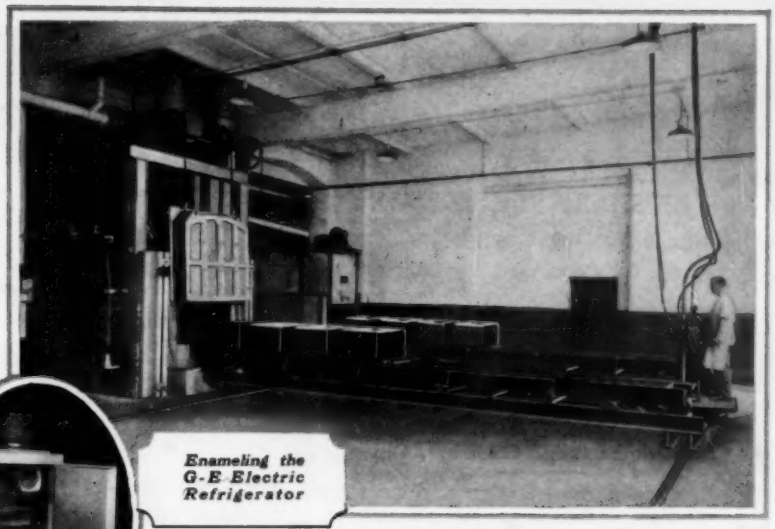
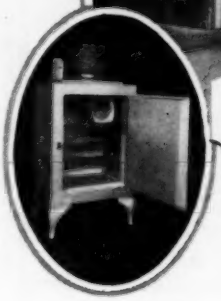


Enameling the G-E Electric Refrigerator



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Electric heat does a masterful job with these refrigerators. Its speed is astounding. There are no rejections. The uniform quality of the enamel is rigidly maintained. The product and the entire enameling room are clean. Only one man operates the entire job. And the cost is no more than if fuel were used for the heat.

Let G-E heating specialists help you with your enameling problems. Call your nearest G-E office.

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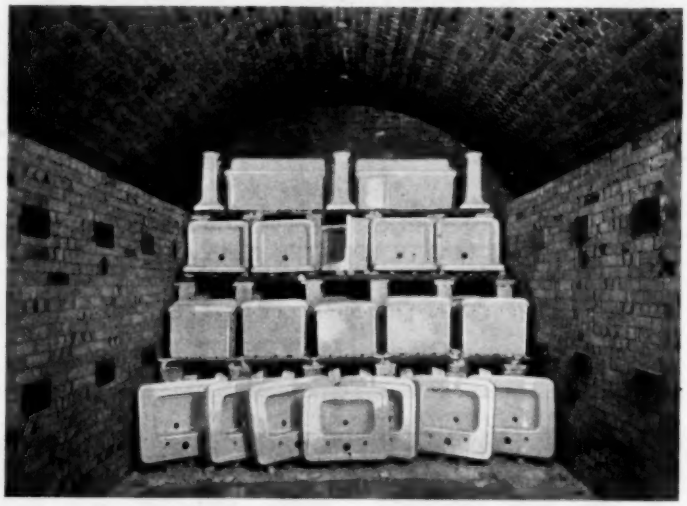

One of the seven Carbo-Radiant Kilns in operation at the Fords Porcelain Works Perth Amboy, N. J.

THIS is a new type of much interest to the Ceramic industry—a direct fired kiln, burning oil, producing glazed ware formerly burned in muffle kilns.

¶The necessary control of kiln atmosphere and temperature is obtained by the use of Carborundum Carbo-Radiant Combustion Chambers.

¶No muffle is used. This reduces the fuel consumption by approximately 40 per cent.

¶This direct firing method eliminates the lag in heating and cooling which occurs when muffles are used thus giving a quicker kiln turnover.

¶This kiln is operated with two or four oil burners instead of the usual eight to fourteen.

¶The costly maintenance of muffles and fireboxes is eliminated, as well as loss of production due to shutdowns.

¶Simplicity of heat control—economy of operation—a clean kiln atmosphere and a reduction of spoiled ware is assured with the use of this kiln.

¶The kiln being rectangular is easy to load and unload. It gives the maximum kiln capacity for the floor space occupied.

¶Since burners are located at front and rear, these kilns may be built in battery with no waste space between kilns.

The Carbo-Radiant Direct Fired Kilns are designed and built by The Carborundum Company, Perth Amboy, N. J.

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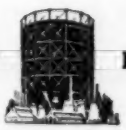
American Gas Association
420 Lexington Avenue, New York City

YOU CAN DO IT  BETTER WITH GAS

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"The CORUNDITE lined covers are lasting twice as long as previous ones."

Here may be the solution for the difficulties of other users of fire brick and refractories. CORUNDITE experts will gladly show you how without obligation.

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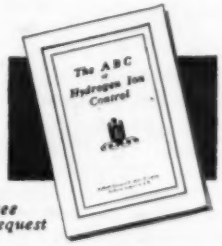

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What a stalled engine taught a growing industry

THE engine that drove the roll train in the little sheet mill would sometimes choke, heave, shudder and then stop. Some one had stalled the engine.

Cost of production went up when the engine stopped. The superintendent wondered what he could do about it. Finally he called the men together and gave them a straightout talk. He told them the seriousness of the situation. Then he said: "I'm going to lay off the man that stalls that engine. He will get from three to thirty days."

The men went back to their work. Before long the engine choked and stopped. A man went home for three days. The engine ran fairly well for a few days after that. But the trouble wasn't over.

One day a workman said: "Say, do you know you don't always get the right guy?" To which the superintendent responded: "I know I don't. I suppose I'm wrong most of the time. But if you men won't tell me who is the 'right guy,' then the 'wrong guy' will have to pay the penalty."

What the Superintendent Did

Then a thought came to the superintendent. "Say, I'll tell you what I'm going to do. I'm going to turn the thing over to you. Appoint your own committee. Then *you* decide who is to blame and you determine the penalty."

The men were willing. They made Billy the chairman.

What happened? The right man was always penalized; the punishment was more severe.

Gradually the trouble died out. But one day the door of the superintendent's office flew open and in came Billy the chairman. His eyes were snapping. When he got to the superintendent, this abrupt intruder snapped out: "Laid myself off for five days; stalled the damned engine!" And he was gone as quickly as he came.

This incident happened years ago when The American Rolling Mill Company was a small institution employing a few hundred men. Today

Incidents That Have Pointed the Way—No. 1 of a Series

Armco has more than 7,000 men and women on the payroll. It is the second largest manufacturer of sheet metal in the world.

But out of the formation of that early committee came the Armco Advisory Committee, by which forty separate and distinct committees today successfully serve as the connecting link between men and management.

The application of incidents to industrial progress is the natural evolution of institutional growth. Understanding vitalizes human effort. The men of Armco work together for a common purpose in the manufacture of long lasting, commercially pure iron.

Ideal for Vitreous Enameling

Enamelers everywhere find in ARMCO Ingot Iron the solution to many vexatious problems. Being pure, uniform and virtually degasified, it reduces cull losses, thereby increasing plant profits. Moreover, ARMCO Ingot Iron has a velvety-textured surface which grips and holds enamel. From the ground coat to the finished job it consistently produces *results.*

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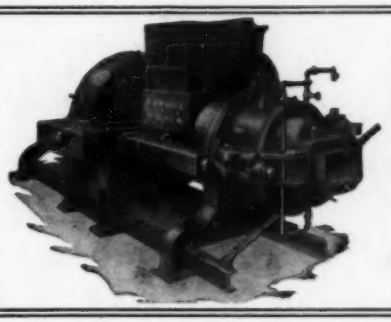

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A recently perfected instrument that is revolutionizing industrial methods.

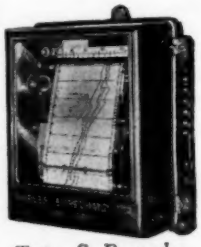
During oxidation — plenty of air!

"It is this period above all other stages of burning during which there should be plenty of air in the kiln, since it is by means of the air which combines with the carbon in the ware that the carbon is removed in the form of carbon dioxide."
Clay Products Cyclopedia, 1926, p. 144.

Engelhard CO_2 Analyzer is valuable in controlling kiln and boiler conditions and in promoting combustion efficiency.

It connects with Engelhard Type S Recorder to make a continuous graphic chart of its readings. Both instruments are reliable, rugged, simple, and *enduringly accurate.*

Write our Ceramic Engineering Dept. for illustrated descriptive bulletins.



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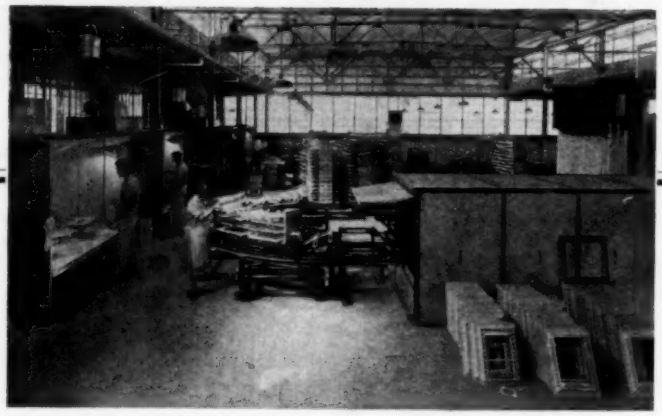
in a Modern Enameling Plant



THE photograph shows "HURRICANE" Dryers in a job enameling plant, described in "The Enamelist," as "Industry's Newest and Finest Plant." The manager of the plant speaks of the dryers as follows:

"Our carrousal conveyors carry the ware into the dryers immediately after it is sprayed and we have had *no trouble whatever* in drying *all sizes and shapes* of castings and sheets in these dryers. We use a "HURRICANE" Dryer, forty feet long. We blow air at a rate of 3,000 ft. a minute, heated by steam to 190 degrees F., through a duct in the bottom of this dryer; and although our steam pressure varies from 10 pounds to 15 pounds, we have no trouble in keeping the temperature of the dryer up to 170 degrees F. The speed of the conveyor is changed from 15′ to 5′ a minute, yet ware is not cracked and is always dry when it comes out."

THE PHILADELPHIA DRYING MACHINERY CO.

Specialists in Drying Machinery

Backed by nearly 30 Years' Experience

Stokley Street above Westmoreland, Philadelphia, Pa.

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53 State St., Boston, Mass.

HURRICANE
Ideal Drying Every Day
67

THE 1928 annual meeting of the National Brick Manufacturers Association and the American Ceramic Society will be the biggest ceramic meeting of the year. The attendance is expected to reach the highest figure of any meeting yet held. The exhibits are being arranged on such a scale that additional exhibit space is being located. Everything from delicate instruments to conveyors and tractors has been scheduled for exhibition.

If you cannot handle the details and plans for your exhibit, use your advertising agent or agency. Tell them what you want to show and tie it up with your advertising campaign whether you use the *Journal* or the trade papers.

Every company catering to the ceramic trade is invited to make an exhibit. If you have misplaced your application for space, write us again and we will furnish you with the details.

The week following the annual meetings at Atlantic City, the Common Brick Manufacturers will meet at Washington, D.C. What better opportunity do you want to make two exhibits and sales campaigns for practically the cost of one?

Joint Exhibit Committee

AMERICAN CERAMIC SOCIETY

2525 N. High Street, Columbus, Ohio

There is no Substitute for Tin Oxide

Consequently, during 1927 we sold more tin oxide than in any previous year in the history of the Corporation.

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Each month we are gaining new customers for our tin oxide—and they keep on buying. Evidently these firms are finding that the best opacifier at any price is—

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A good article sold at a fair price will find an ever widening market.

Metal & Thermit Corporation

Ceramics Department

HOMER F. STALEY, *Mgr.* R. R. DANIELSON, *Dir. of Research*

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